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Addendum to the Baseline Human Health Risk Assessment
Former CENCO Refinery
12345 Lakeland Road, Santa Fe Springs, CA

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TABLE OF CONTENTS

TABLE OF CONTENTS	ii
LIST OF TABLES	iii
LIST OF FIGURES	iii
LIST OF APPENDICES.....	iii
1. INTRODUCTION	1
1.1 Report Organization	1
1.2 Site Description and History	2
2.0 ADDITIONAL ASSESSMENT OF RISKS FROM VOCs.....	3
2.1 Indoor Air.....	3
2.1.1 Residential Receptors.....	3
2.1.2 Commercial/Industrial Workers	4
2.2 Outdoor Air.....	5
3.0 ADDITIONAL ASSESSMENT OF SOIL MATRIX RISKS	6
4.0 EVALUATION OF LEAD RISK BASED ON UPDATED CALEPA METHOD.....	8
5.0 EVALUATION OF METHANE RISK.....	10
6.0 RE-CALCULATION OF CLEANUP GOALS	12
7.0 EVALUATION OF OFF-SITE RECEPTORS	13
8.0 UPDATED RISK CHARACTERIZATION	14
9.0 ADDITIONAL HRA CLARIFICATIONS	15
10.0 REFERENCES	16
11.0 CLOSING.....	17

LIST OF TABLES

Addendum Table 1	Results of Indoor Air Step 1 Screen
Addendum Table 2	Soil Gas RBCs Indoor Air (Step 2)
Addendum Table 3	Cumulative ILCRs and HIs for Indoor Air (Step 4)
Addendum Table 4	Statistical Summary of Soil Dataset for Surface Soil (0-0.5 ft) Area 3
Addendum Table 5	Data Evaluation and Selection of COPCs for Surface Soil (0-0.5 ft) Area 3
Addendum Table 6	Cumulative ILCR and HI for Onsite Commercial/Industrial Worker Receptor – Surface Soil (0-0.5 ft) Area 3
Addendum Table 7	Cumulative ILCRs and HIs for Direct Contact Soil Pathways
Addendum Table 8	Soil Matrix RBCs for Onsite Commercial/Industrial Worker Receptor
Addendum Table 9	Updated Risk Characterization Summary

LIST OF FIGURES

Addendum Figure 6-1	Conceptual Site Model
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LIST OF APPENDICES

Appendix A	April 15, 2011 Response to Comments Letter by Murex Environmental
Appendix B	Indoor Air Assessment Calculation Files (CD-ROM)
Appendix C	Soil Matrix Calculation Files (CD-ROM)
Appendix D	Revised HRA Tables

1. INTRODUCTION

As requested by the Department of Toxic Substance Control's (DTSC) Human and Ecological Risk Office (HERO), Murex Environmental (Murex) has prepared this Addendum to the *Baseline Human Health Risk Assessment, Former CENCO Refinery, Santa Fe Springs, California* (HRA) for the former refinery property located at 12345 Lakeland Road in Santa Fe Springs, California (Site).

The baseline HRA was prepared by Arcadis in September 2009. DTSC/HERO provided comments summarizing the results of their review of the HRA in January 2011. Murex formally responded to the DTSC comments in a letter dated April 15, 2011 (**Appendix A**). During an April 12, 2011 teleconference between Murex staff and the DTSC/HERO staff, the responses were discussed, and an approach for the presentation of this HRA Addendum was agreed upon. This document has been prepared to comprehensively address DTSC's request for additional components to the HRA described in their January letter and that call.

1.1 Report Organization

The Addendum is organized as follows:

Section 1.0: Introduction

Section 2.0: Additional Assessment of Air Risks Associated with Volatile Organic Chemicals (VOCs)

Section 3.0: Additional Assessment of Soil Matrix Risks

Section 4.0: Evaluation of Lead Risks Based on Updated CalEPA Method

Section 5.0: Evaluation of Methane Risks

Section 6.0: Re-Calculation of Cleanup Goals

Section 7.0: Evaluation of Offsite Receptors

Section 8.0: Updated Risk Characterization

Section 9.0: Additional HRA Clarifications

Section 10.0: References

Section 11.0: Closing

1.2 Site Description and History

The site is approximately 55 acres in size and is bordered to the north by Florence Avenue, to the south by Lakeland Road, and to the east by Bloomfield Avenue. The Site is bordered on all sides by commercial and industrial properties. The site was operated as an oil refinery from the 1930s until July 1995. Historical aerial photographs indicate that the western portion of the site may have been used for agricultural purposes from approximately 1928 to 1938. Oil-production-related structures such as ponds and aboveground holding tanks may have also been located onsite during these years (Haley & Aldrich, Inc. [Haley & Aldrich], 2005). The refinery is not currently in operation; however, some of the refinery structures remain onsite. These structures are scheduled to be removed prior to the redevelopment of the property for commercial/industrial use.

Previous refining operations included processing crude oil into several grades of fuel including kerosene, leaded gasoline and aviation fuel, unleaded gasoline, jet fuel, high and low-sulfur diesel, fuel oil, and petroleum coke. Soil and groundwater quality beneath and in proximity to the site have been impacted by past site operations. Soil and groundwater investigations are being conducted pursuant to a Cleanup and Abatement Order (No. 97-118) issued by the LARWQCB to Powerine Oil Company (CENCO Refining Company) in 1997.

2.0 ADDITIONAL ASSESSMENT OF RISKS FROM VOCs

DTSC requested that risks associated with soil gas and subsequent indoor and outdoor¹ air exposure scenarios be characterized for each soil gas data point² (as opposed to using a 95% upper confidence interval [UCL] on a mean concentration within a site sub-area, which was the approach used in the HRA) (*DTSC comment #3 and comment #6*). In addition, DTSC has requested that, for cases where the 10 ft soil gas sample data are greater than twice the concentration of the 5 ft sample, further analysis (i.e., fate/transport modeling and risk characterization) be conducted based on the 10 ft concentrations (*DTSC comment #2*).

Based on the large number of soil gas data points, a tiered approach, described below, was applied to characterize risks associated with indoor and outdoor air.

2.1 Indoor Air

2.1.1 Residential Receptors

We note that, for the residential scenario, the indoor incremental lifetime cancer risk (ILCR³) associated with soil exposure ranges from 2×10^{-54} to 4×10^{-5} for Areas 1 – 4 (Arcadis, 2009, Tables F-7, F-17, F-27, and F-37) based on the area-specific UCLs employed in the HRA. These ILCRs exceed the target ILCR for residential land use. Therefore, the residential indoor ILCR using the maximum soil gas concentrations (and certain other individual data points) would result in even greater ILCRs. Accordingly, modeling and risk characterization based on maximum soil gas concentrations was not warranted, as that risk characterization would continue to result in ILCRs that exceed the target for residential land use.

¹ Exposure and risks associated with VOCs in outdoor air were not assessed for chronic receptors (residents and long-term workers) in the original HRA (*DTSC comment #3*).

² This approach would include, and would be driven by, the maximum concentration data point(s).

³ The HRA Addendum employs this term for the cancer risk endpoint. The ILCR is equivalent to the ELCR (excess lifetime cancer risk) term used in the HRA and the HRA tables and appendices.

⁴ Equivalent to 1E-06, the latter notation is used in the remainder of the report.

2.1.2 Commercial/Industrial Workers⁵

In order to address DTSC comment #6, yet minimize the number of model runs, a tiered approach was employed as follows:

Step 1 – Risks associated with the maximum soil gas concentrations reported for each of the four sub-areas (Areas 1-4) were input into the Johnson & Ettinger (J & E) model as the basis for Step 1. The chemicals of potential concern (COPCs) (chemicals detected in at least one soil gas sample), the ILCR, and the noncancer hazard index (HI), associated with the maximum COPC concentrations for each of the four sub-areas were determined and are summarized in **Addendum Table 1**. J & E model files and risk calculation files are provided in **Appendix B**. For all four sub-areas, the maximum soil gas concentrations resulted in cancer risks and/or noncancer hazard indices that exceed target levels. Accordingly, Step 2 was conducted.

Step 2 – For each COPC and soil vapor data point, the detected concentration (or one-half the detection limit if non-detect) was compared to one-tenth of the shallow soil gas CHHSL (CalEPA, 2005) for commercial/industrial land use. In the case of soil gas data points for which any COPC concentration exceeded one-tenth of its respective CHHSL (see highlighted fields in **Appendix B**), that data point was carried into Step 3, where risk-based concentrations (RBCs) were calculated for COPCs having Step 2 exceedances.

Step 3 – All of the six detected chemicals in soil gas (benzene, ethylbenzene, o-xylene and m/p-xylenes, toluene, cis-1,2-dichloroethene [1,2-DCE], and trichloroethene [TCE]), exceeded the Step 2 screen in at least one area, so risk-based concentrations (RBCs) were calculated for each of these COPCs using the J & E model, a unit soil vapor concentration of 1 µg/m³, a target ILCR of 1×10^{-66} , a target HI of 1, and default J & E parameters⁶. The soil gas RBCs are presented in **Addendum Table 2**. J & E model files and RBC calculation files are provided in **Appendix B**.

Step 4 – All individual chemicals and data points exceeding the RBC were identified. For data points where at least one chemical exceeded the lowest RBC (cancer-based or noncancer-based), the ILCR for each carcinogen was then calculated by multiplying the

⁵ Current commercial/industrial workers and future commercial/industrial workers have exactly the same indoor risks in the HRA, as well as the HRA Addendum, as the EPCs and the exposure factors are the same for both receptors.

⁶ Equivalent to 1E-06, the latter notation is used in the remainder of the report.

⁷ The only site-specific model parameter employed was soil type, which was set at silty clay per site characteristics.

10^{-6} -based RBC by the chemical concentration. The cumulative ILCR for that data point was then calculated by summing the chemical-specific ILCRs. For the same set of data points, the COPC-specific HI was calculated by dividing the chemical concentration by the RBC. This approach is consistent with the methodology that is outlined in the CalEPA CHHSL guidance for risk characterization of multiple chemicals (CalEPA, 2005, Section 2.8) and eliminated the need for hundreds of J & E model runs. A summary of the results of Step 4 (minimum and maximum ILCR and HIs by depth and area) is provided in **Addendum Table 3**. Calculation spreadsheets are provided in **Appendix B**.

As per DTSC comment #2, a discussion is warranted regarding the effect of using the 10-ft-bgs data, as the basis for indoor vapor risks, for chemicals that have the maximum concentration more than twice that at 5-ft-bgs. For the revised indoor air assessment in this HRA Addendum, indoor air risks were characterized for all soil gas data points (i.e., the 10-ft data were quantitatively assessed for all 10-ft data points, not just those having COPC concentrations greater than twice the 5-ft concentration). A comparison of the ILCR and HI results for the maximum ILCR and HI locations (for each area, see **Addendum Table 3**) shows the following: for Area 1, the 5-ft ILCR is 4 times higher than the 10-ft ILCR (4E-03 versus 1E-03). For Areas 2, 3 and 4, the 5-ft ILCR is approximately one-half of the 10-ft ILCR (Area 2: 3E-03 versus 7E-03; Area 3: 2E-03 versus 5E-03; Area 4: 4E-03 versus 7E-03). The 5-ft versus 10-ft comparison results for the HIs are similar (note: all maximum HIs exceed 1). The revised risk characterization employed the higher of the two indoor air ILCRs (5-ft-based or 10-ft-based) as the basis for the multi-pathway cumulative ILCRs and HIs.

2.2 Outdoor Air

DTSC (comment #3) requested that inhalation of vapor in outdoor air be included in the HRA. Inhalation of vapors in outdoor air was not assessed in the HRA for the long-term residential or long-term commercial industrial worker receptors, as the HRA assumed that these receptors were always indoors (i.e., the HRA assumed indoor exposure time for the resident to be 24 hr/day and for the long-term worker to be 8 hr/day). Based on this conservative HRA assumption⁸, it was not necessary to include assessment of exposure to vapors in outdoor air for the long-term receptors. The outdoor air pathway was quantitatively assessed in the HRA for the short-term construction worker and short-term utility/trench worker.

⁸ Indoor air exposure point concentrations (EPCs) and risks are higher than outdoor air EPCs and risks.

3.0 ADDITIONAL ASSESSMENT OF SOIL MATRIX RISKS

DTSC (comment #1) also requested that a separate evaluation of the 0-0.5 foot soil depth interval be conducted for Area 3. This exposure depth interval is relevant for the commercial/industrial worker, but not the construction worker or utility/trench worker. A summary of this soil dataset is presented in **Addendum Table 4** (this table is of the same format as used in the HRA for the other soil datasets, HRA Tables 5-1 through 5-13). Data evaluation and selection of COPCs is presented in **Addendum Table 5** (this table is of the same format as used in the HRA for the other soil datasets, HRA Tables 6-1 through 6-13). Exposure point concentrations (UCLs) for this dataset are included in Revised HRA Table 6-16, contained in **Appendix C** (Excel® file) and Appendix D (pdf). ILCR and HI calculations for the onsite commercial/industrial worker for the 0-0.5 ft exposure scenario for Area 3 are presented in **Addendum Table 6**. (this table is of the same format as used in the HRA for the other soil datasets, HRA Tables F-1 through F-40). Updated exposure factors were employed (see below).

At DTSC's request (DTSC comment #7), risk calculations for soil matrix were recalculated using the following exposure factors: for commercial/industrial workers, the soil ingestion rate of 100mg/day and for construction/utility trench workers, the soil adherence factor of 0.8 mg/cm²/day (CalEPA/DTSC, 2005). For purposes of the HRA Addendum, risks were characterized for a "current/future" commercial/industrial worker, for the receptor-specific soil depth intervals⁹. Risks were not re-calculated for residential receptors, as reassessment using the more stringent exposure factors for soil ingestion (DTSC comment #7) would result in soil-related ILCRs greater than the soil-related ILCRs reported in the HRA and would not change the risk conclusions already presented in the HRA, (which range for the four areas from 2E-05 to 4E-05(Arcadis, 2009, Tables F-7, F-17, F-27, and F-37).

A summary of the ILCRs and HIs for the onsite commercial/industrial worker is provided in **Addendum Table 7**. All soil matrix-related calculation spreadsheet files are contained in **Appendix C**.

DTSC also recommended that risk characterization for the residential exposure scenario to site soils be calculated using the maximum concentrations rather than UCLs (DTSC comment # 1 and comment #5). The UCL-based residential ILCRs for soil pathways range from 2E-05 to 4E-05. As discussed above, these UCL-based risks exceed target levels for

⁹ Commercial/Industrial Worker: Area 1: 0- to 2-ft; Area 2: 0- to 2-ft; Area 3: 0- to 0.5 ft and 0- to 2-ft; Area 4: 0- to 2 ft. Construction and utility/trench workers: Areas 1-4: 0- to 10-ft).

residential land use (Arcadis, 2009, Tables F-7, F-17, F-27, and F-37). Therefore, recalculating residential soil risks using the maximum concentration was not warranted.

4.0 EVALUATION OF LEAD RISK BASED ON UPDATED CALEPA METHOD

DTSC requested that the lead data for the site be evaluated using updated CalEPA guidance (CalEPA/OEHHA, 2009) (DTSC comment #8). Accordingly, comparisons of the lead UCL (and maximum concentration) for each area (and each soil exposure depth interval dataset) with the updated commercial/industrial California Human Health Screening Level (CHHSL) of 320 mg/kg and the updated residential CHHSL of 80 mg/kg (CalEPA/OEHHA, 2009) was conducted. For all four areas, the maximum lead concentration exceeds the commercial/industrial CHHSL. The UCL-based EPC exceeds the commercial/industrial CHHSL for Area 3 only. The UCLs and maximum concentrations exceed the residential CHHSL for all four areas. A summary of the results is provided below.

Updated Lead Assessment Summary

Commercial/Industrial Receptor

	Lead EPC (0-2 ft) mg/kg	Lead EPC (0-10 ft) mg/kg	Lead EPC 0-0.5 ft mg/kg
Comm./Indus. CHHSL* = 320 mg/kg			
Sub-Area 1	217 (4,240)	145 (4240)	NA
Sub-Area 2	137 (4,690)	93.8 (4,690)	NA
Sub-Area 3	687 (47,300)	452(47,300)	406 (25,700)
Sub-Area 4	244 (3,810)	160 (3,810)	NA

* CalEPA/DTSC, 2009.

NA – not applicable.

Primary values represent the UCL; values in parentheses represent the maximum concentration.

Bold results exceed the commercial/industrial CHHSL.

Onsite Residential Receptor

	Lead EPC (0-2 ft) mg/kg	Lead EPC (0-10 ft) mg/kg	Lead EPC 0-0.5 ft mg/kg
Residential CHHSL* = 80 mg/kg			
Sub-Area 1	217 (4,240)	145 (4240)	NA
Sub-Area 2	137 (4,690)	93.8 (4,690)	NA
Sub-Area 3	687 (47,300)	452(47,300)	406 (25,700)
Sub-Area 4	244 (3,810)	160 (3,810)	NA

* CalEPA/DTSC, 2009.

NA – not applicable.

Primary values represent the UCL; values in parentheses represent the maximum concentration.
Bolded results exceed the residential CHHSL.

5.0 EVALUATION OF METHANE RISK

DTSC requested that the methane data for the site be evaluated by comparing with methane-specific explosive limits (i.e., lower explosive limit [LEL]) (DTSC comment #10).

Methane in soil beneath buildings is a concern for the health and safety of building occupants, because of the increased risk of fire or explosion. Methane gas, or “natural” gas, is combustible between 5% (LEL) and 15% UEL) in air by volume in an enclosed area. Methane commonly forms in areas where buried organic matter (especially petroleum hydrocarbon material) decays in the presence of moisture.

Buildings with a slab-on-grade foundation are at particular risk because of the potential for cracks in the building slab or utility penetrations to become conduits for methane seepage into an enclosed space within the first floor of a structure.

Historical data, as well as field data and observations recorded during currently ongoing pilot testing for the design of full scale vadose zone remediation, indicate that methane is present in the subsurface at concentrations above the lower explosive limit of 53,500 parts per million by volume (ppmV). This condition is common in the City of Santa Fe Springs, where historical petroleum exploration and extraction was widespread.

The risk to human health from methane in site soil is a known condition to the City of Santa Fe Springs, as on most property within the City. As a result, methane/vapor intrusion protection is required on all occupied structures within the City.

Passive venting combined with an impermeable sub-slab barrier is the most appropriate approach for long-term management of methane beneath newly constructed buildings. The combination of blocking any inlets for methane seepage and the open venting of methane to the atmosphere provides an adequate factor of safety, sufficient for any commercial or residential application.

Using impermeable membranes, which can be sheets that are heat welded or liquid that is spray-applied, buildings can be constructed to limit the ability of vapors to seep inside. Additionally, collection and vent piping installed within the building structure are used to safely redirect any vapors from building up beneath the floor slab.

Based on the types of VOCs identified, and the likely range of methane concentrations, Murex recommends the use of a minimum 60-mil thick high-density polyethylene (HDPE)

liner system or Liquid Boot spray-applied liner installed underneath each slab-on-grade structure constructed in the Project, installed over a network of sub-slab vent piping, which will allow vapors collected under each building to vent harmlessly to the atmosphere.

6.0 RE-CALCULATION OF CLEANUP GOALS

DTSC requested that cleanup goals (RBCs) be updated based on the incorporation of the January 2011 DTSC comments (DTSC comment #12). The soil gas RBCs calculated as a component of Section 2 represent updated commercial/industrial cleanup goals for soil gas. These are summarized in **Addendum Table 2**. Updated soil matrix RBCs for the commercial/industrial worker are summarized in **Addendum Table 8**. Associated calculation files are provided in **Appendix B** (for soil gas/indoor air) and **Appendix C** (for soil matrix).

7.0 EVALUATION OF OFF-SITE RECEPTORS

DTSC (comment #4) requested that a quantitative assessment of additional exposure pathways for offsite receptors (e.g., indoor vapors), be assessed. As the offsite data are not yet available, this assessment will be submitted under separate cover as agreed during the April 12 teleconference.

8.0 UPDATED RISK CHARACTERIZATION

DTSC comment #11 requested an updated summary regarding the results of the risk characterization. The updated risk characterization summary is provided in **Addendum Table 9**.

9.0 ADDITIONAL HRA CLARIFICATIONS

As a component of the HRA Addendum, an updated conceptual site model (CSM) is included as Addendum Figure 6-1. This updated CSM reflects DTSC comments addressed in this addendum. Additional HRA clarifications relevant to DTSC comments are summarized below.

DTSC *comment #5* requested specification as to under what condition the maximum detected concentration was selected as the EPC. As stated in Murex's response to DTSC comments (Murex, 2011, Attachment A), the maximum soil concentration was used as the EPC for datasets of less than eight samples.

DTSC *comment #6* requested justification for the soil parameter values used in the J & E model and in the calculation of volatilization factors. As stated in Murex's response to DTSC comments (Murex, 2011, Attachment A), all soil parameter values were default with the exception of chemical concentration in soil and soil type, which was set at silty clay per site characteristics.

DTSC *comment #9* requested clarification as to whether chronic or sub-chronic non-carcinogenic toxicity values were used to evaluate the utility trench workers. As stated in Murex's response to DTSC comments (Murex, 2011, **Appendix A**), subchronic toxicity criteria were used, where available. Chronic toxicity criteria were used where subchronic values were not available.

10.0 REFERENCES

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2. CalEPA, 2005. Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties, January.
3. <http://www.calepa.ca.gov/Brownfields/documents/2005/CHHSLsGuide.pdf>
4. CalEPA/Department of Toxic Substances Control (CalEPA/DTSC), 2005. Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Military Facilities, Human and Ecological Risk Division, October 27.
5. http://www.dtsc.ca.gov/AssessingRisk/upload/HHRA_Note1.pdf.
6. CalEPA/Office of Environmental Health Hazard Assessment (CalEPA/OEHHA), 2009. Revised California Human Health Screening levels for Lead, September. <http://www.oehha.org/risk/pdf/LeadCHHSL091709.pdf>
7. CalEPA/DTSC, 2010. Review of Baseline Human Health Risk Assessment Report, Former CENCO Refinery, Santa Fe Springs, CA. From S. Steve Harari, M.S., P.E. (DTSC) to Don Indermill, P.G. (Los Angeles Water Quality Control Board), January 10.
8. Murex Environmental, Inc. (Murex), 2011 (April 15). Response to Comments Regarding: DTSC Memo Dated January 10, 2011 – Comments to the Baseline Human Health Risk assessment, Former CENCO Refinery, Santa Fe Springs, California (Arcadis, 2009).
9. Murex, 2010. Groundwater Monitoring & Investigation Workplan, Former CENCO Refinery, Santa Fe Springs, California. Prepared for Isola Law Group, LLP. September 3.
10. Versar. 2000. Revised Master Workplan, CENCO Refining Company, Santa Fe Springs, California (January 2000).

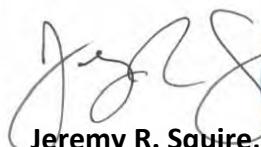
11.0 CLOSING

Should you have any questions or concerns regarding the material herein, please do not hesitate to contact the undersigned at (714) 508-0800.

Sincerely,
MUREX ENVIRONMENTAL, INC.



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Addendum Table 1 - Results of Indoor Air Step 1 Screen*

Former Cenoco Refinery
Santa Fe Springs, California

Chemical	Area 1				Area 2				Area 3				Area 4			
	5 ft soil gas data		10 ft soil gas data		5 ft soil gas data		10 ft soil gas data		5 ft soil gas data		10 ft soil gas data		5 ft soil gas data		10 ft soil gas data	
	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR
Benzene	5.9	3.70E-03	**	**	4.9	3.00E-03	***	***	3.6	2.20E-03	***	***	6.3	3.90E-03	***	***
Ethylbenzene	0.42	7.50E-04	**	**	0.013	2.40E-05	***	***	0.14	2.50E-04	***	***	0.021	3.80E-05	***	***
o-Xylene	1.7	NA	**	**	0.0038	NA	0.03	NA	0.37	NA	0.95	NA	0.017	NA	0.45	NA
m,p-Xylene	4.9	NA	**	**	0.024	NA	0.2	NA	0.91	NA	3.1	NA	0.098	NA	1.4	NA
Toluene	7.9	NA	**	**	0.089	NA	0.41	NA	1.5	NA	**	**	0.14	NA	0.92	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	0.047	NA	0.14	NA	ND	ND	0.0083	NA
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	0.0014	6.20E-07	0.0065	2.80E-06	ND	ND	0.0012	5.10E-07

- Values above HI = 1 or ILCR >10-5.

HI - Hazard index

ILCR - Incremental lifetime cancer risk

* Indoor air J&E model input exposure point concentration was the maximum detected soil gas concentration in the area.

** 10 ft soil gas concentration < 2X the 5 ft soil gas concentration.

*** 10 ft soil gas concentration >2X the 5 ft soil gas concentration but ILCR > 10-5.

Addendum Table 2
Soil Gas RBCs Indoor Air (Step 2)
Former CENCO Refinery
Santa Fe Springs, California

Chemical	ILCR = 10^{-6} RBC µg/L		HI=1 RBC µg/L		Final RBC* µg/L	
	5 Feet	10 Feet	5 Feet	10 Feet	5 Feet	10 Feet
Benzene	0.13	0.20	77	125	0.13	0.20
c-1,2-Dichloroethene	NA	NA	83	143	83	143
Ethylbenzene	1.59	2.63	2857	4762	1.59	2.63
o-Xylene	NA	NA	909	1471	909	1471
p/m-Xylene	NA	NA	1000	1613	1000	1613
Toluene	NA	NA	400	625	400	625
Trichloroethene	1.92	3.13	833	1351	1.92	3.13

NA: Not applicable; chemical is not carcinogenic.

*Value presented is the lowest of the ILCR and HI RBC.

ILCR: Incremental lifetime cancer risk.

HI: Hazard index.

RBC: Risk based concentration.

Addendum Table 3
Cumulative ILCRs and HIs for Indoor Air (Step 4)
Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Area	Minimum ILCR	Maximum ILCR	Minimum ILCR	Maximum ILCR	Minimum HI	Maximum HI	Minimum HI	Maximum HI
	5 Feet	5 Feet	10 Feet	10 Feet	5 Feet	5 Feet	10 Feet	10 Feet
Area 1	4E-06	4E-03	3E-06	1E-03	0.0067	19.7	0.0041	6
Area 2	4E-06	3E-03	3E-06	7E-03	0.0067	4.9	0.0041	11.1
Area 3	5E-06	2E-03	3E-06	5E-03	0.0073	5.9	0.0045	12.5
Area 4	5E-06	4E-03	3E-06	7E-03	0.0073	6.6	0.0045	11.7

ILCR: Incremental lifetime cancer risk

HI: Hazard index.

Addendum Table 4
Statistical Summary of Soil Dataset
Surface Soil (0-0.5 foot)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Constituent [a]	Frequency of Detection (FOD) [b]		Detects		Detection Limits		Maximum Location	Exposure Point Concentration [c] (mg/kg)
	Number of Detects / Number of Samples	FOD %	Minimum - Maximum (mg/kg)	Minimum - Maximum (mg/kg)	Minimum - Maximum (mg/kg)	Maximum Location		
Volatile Organic Compounds (VOCs)								
1,1,1-Trichloroethane	1 - 104	0.962	0.0038 - 0.0038	0.0004 - 0.25	S181-0"	0.0038 m		
1,1,2-Trichloroethane	1 - 104	0.962	0.0026 - 0.0026	0.0004 - 0.25	S039-0"	0.0026 m		
1,2,4-Trichlorobenzene	1 - 104	0.962	0.17 - 0.17	0.00081 - 0.49	S078-0"	0.17 m		
1,2,4-Trimethylbenzene	16 - 104	15.4	0.0025 - 8.6	0.001 - 0.49	S037-0"	0.6818		
1,2-Dichlorobenzene	2 - 104	1.92	0.0012 - 2.9	0.0004 - 0.25	S078-0"	2.9 m		
1,2-Dichloropropane	3 - 104	2.88	0.0053 - 0.02	0.0004 - 0.25	S045-0"	0.02 m		
1,3,5-Trimethylbenzene	8 - 104	7.69	0.01 - 5.3	0.001 - 0.49	S037-0"	0.1678		
1,4-Dichlorobenzene	1 - 104	0.962	0.4 - 0.4	0.0004 - 0.25	S078-0"	0.4 m		
2-Butanone	43 - 104	41.3	0.018 - 0.15	0.0081 - 4.9	S172-0"	0.03776		
Acetone	43 - 104	41.3	0.041 - 0.26	0.039 - 12	S087-0"	0.1178		
Benzene	34 - 104	32.7	0.00073 - 4.3	0.00051 - 0.25	S175-0"	0.3559		
Bromodichloromethane	3 - 104	2.88	0.0022 - 0.14	0.0004 - 0.25	S267-0"	0.14 m		
c-1,2-Dichloroethene	1 - 104	0.962	0.0019 - 0.0019	0.0004 - 0.25	S040-0"	0.0019 m		
Carbon Disulfide	3 - 104	2.88	0.01 - 0.043	0.004 - 2.5	S058-0"	0.043 m		
Chloroform	8 - 104	7.69	0.0014 - 0.26	0.0004 - 0.25	S267-0"	0.0132		
Ethylbenzene	15 - 104	14.4	0.0019 - 3	0.00051 - 0.25	S037-0"	0.1016		
Isopropylbenzene	15 - 104	14.4	0.00091 - 4.8	0.00051 - 0.1	S027-0"	0.1626		
Methylene Chloride	2 - 104	1.92	0.022 - 0.57	0.004 - 2.5	S130-0"	0.57 m		
Methyl-t-Butyl Ether (MTBE)	3 - 104	2.88	0.0043 - 0.23	0.00081 - 0.49	S184-0"	0.23 m		
n-Butylbenzene	13 - 104	12.5	0.00089 - 3.8	0.00051 - 0.1	S027-0"	0.1657		
n-Propylbenzene	18 - 104	17.3	0.0035 - 6.2	0.00051 - 0.1	S027-0"	0.2258		
o-Xylene	19 - 104	18.3	0.0011 - 6.2	0.00051 - 0.25	S037-0"	0.4514		
p/m-Xylene	20 - 104	19.2	0.0017 - 8.2	0.00081 - 0.49	S037-0"	0.5988		
p-Isopropyltoluene	14 - 104	13.5	0.0016 - 2.1	0.00051 - 0.25	S037-0"	0.08358		
sec-Butylbenzene	16 - 104	15.4	0.0014 - 5.2	0.00051 - 0.1	S027-0"	0.1743		
Tert-Butyl Alcohol (TBA)	6 - 104	5.77	0.016 - 0.69	0.0081 - 4.9	S051-0"	0.04336		
tert-Butylbenzene	2 - 104	1.92	0.0054 - 0.69	0.0004 - 0.25	S027-0"	0.69 m		
Tetrachloroethene	1 - 104	0.962	0.002 - 0.002	0.0004 - 0.25	S031-0"	0.002 m		
Toluene	30 - 104	28.8	0.00073 - 3.8	0.0004 - 0.25	S037-0"	0.3869		
Trichloroethene	1 - 104	0.962	0.0026 - 0.0026	0.00081 - 0.49	S081-0"	0.0026 m		
Xylenes, total	23 - 104	22.1	0.0017 - 14.4	0.001 - 0.49	S037-0"	1.045		

Addendum Table 4
Statistical Summary of Soil Dataset
Surface Soil (0-0.5 foot)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Constituent [a]	Frequency of Detection (FOD) [b]			Detects		Detection Limits		Maximum Location	Exposure Point Concentration [c]			
	Number of Detects / Number of Samples	FOD %	Minimum - Maximum		Minimum - Maximum							
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)						
Semivolatile Organic Compounds (SVOCs)												
1-Methylnaphthalene	21	-	104	20.2	0.11	-	76	0.021	-	1.2	S042-0"	4.948
2-Methylnaphthalene	22	-	104	21.2	0.051	-	72	0.021	-	1.2	S042-0"	4.975
Acenaphthene	13	-	104	12.5	0.12	-	14	0.021	-	1.2	S042-0"	0.6966
Acenaphthylene	4	-	104	3.85	0.19	-	6.2	0.021	-	1.2	S042-0"	6.2 m
Anthracene	9	-	104	8.65	0.14	-	7.3	0.021	-	1.2	S042-0"	0.5387
Benzo(a)anthracene	19	-	104	18.3	0.13	-	7.4	0.021	-	1.2	S042-0"	0.553
Benzo(a)pyrene	19	-	104	18.3	0.024	-	5.1	0.021	-	1.2	S042-0"	0.3032
Benzo(b)fluoranthene	18	-	104	17.3	0.032	-	5.9	0.021	-	1.2	S042-0"	0.3382
Benzo(ghi)perylene	23	-	104	22.1	0.035	-	4	0.021	-	1.2	S075-0"	0.2635
Benzo(k)fluoranthene	14	-	104	13.5	0.024	-	5.4	0.021	-	1.2	S042-0"	0.4342
Chrysene	41	-	104	39.4	0.036	-	7.5	0.021	-	1.2	S042-0"	0.6649
Dibenzo(a,h)anthracene	4	-	104	3.85	0.27	-	3.5	0.021	-	1.2	S042-0"	3.5 m
Fluoranthene	21	-	104	20.2	0.13	-	15	0.021	-	1.2	S075-0"	0.7619
Fluorene	15	-	104	14.4	0.11	-	22	0.021	-	1.2	S042-0"	1.037
Indeno(1,2,3-cd)pyrene	11	-	104	10.6	0.038	-	4	0.021	-	1.2	S075-0"	0.328
Naphthalene	12	-	104	11.5	0.0092	-	43	0.0051	-	2.5	S027-0"	1.421
Phenanthrene	29	-	104	27.9	0.12	-	12	0.021	-	1.2	S075-0"	0.863
Pyrene	42	-	104	40.4	0.025	-	13	0.021	-	1.2	S075-0"	1.483
Pesticides and Herbicides												
4,4-DDE	1	-	13	7.69	0.0057	-	0.0057	0.0053	-	0.0069	S262-0"	0.0057 m
Inorganic Compounds												
Antimony	14	-	104	13.5	0.873	-	14.2	0.774	-	1.19	S045-0"	1.398
Arsenic	104	-	104	100	1.33	-	40.9	-	-	-	S040-0"	7.604
Barium	104	-	104	100	47	-	1800	-	-	-	S036-0"	222.9
Beryllium	98	-	104	94.2	0.269	-	0.887	0.261	-	0.295	S171-0"	0.537
Cadmium	17	-	104	16.3	0.591	-	3.93	0.517	-	0.693	S038-0"	0.834
Chromium	104	-	104	100	4.47	-	2690	-	-	-	S039-0"	204.4
Chromium, Hexavalent	4	-	4	100	0.13	-	2.8	-	-	-	S144B-0"	2.8 m
Cobalt	104	-	104	100	4.33	-	71.5	-	-	-	S037-0"	12.91
Copper	104	-	104	100	12.2	-	1370	-	-	-	S037-0"	147.7
Lead [d]	104	-	104	100	3.34	-	25700	-	-	-	S037-0"	406
Mercury	69	-	104	66.3	0.0978	-	27.6	0.0862	-	0.103	S026-0"	2.74
Molybdenum	72	-	104	69.2	0.279	-	67.9	0.258	-	0.308	S039-0"	6.744

Addendum Table 4
Statistical Summary of Soil Dataset
Surface Soil (0-0.5 foot)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Constituent [a]	Frequency of Detection (FOD) [b]		Detects		Detection Limits		Maximum Location	Exposure Point Concentration [c] (mg/kg)
	Number of Detects / Number of Samples	FOD %	Minimum - Maximum (mg/kg)	Minimum - Maximum (mg/kg)	Minimum - Maximum (mg/kg)	Maximum Location		
Nickel	104 - 104	100	4.77 - 67.4	- - -	- - -	S054-0"	22.75	
Selenium	11 - 104	10.6	0.785 - 3.22	0.776 - 1.04	- - -	S053-0"	0.943	
Thallium	1 - 104	0.962	0.841 - 0.841	0.774 - 1.19	- - -	S028-0"	0.841 m	
Vanadium	104 - 104	100	14.5 - 79.1	- - -	- - -	S040-0"	38.21	
Zinc	104 - 104	100	25.4 - 1740	- - -	- - -	S181-0"	256.3	

Notes:

- = not detected, not analyzed, or not applicable

mg/kg = milligrams per kilograms

[a] Only chemicals detected at least once are presented. For duplicate samples, the highest detected value or the lowest detection limit were used. For

[b] Frequency of detection (FOD) = number of detects / total number of samples analyzed.

[c] The exposure point concentration (EPC) was the upper confidence level on the mean (UCL) or the maximum concentration where the UCL was incalculable. EPCs marked with "m" are based on the maximum detected concentration. The UCLs were calculated using ProUCL 4.0. The UCL used is the one recommended by ProUCL 4.0.

[d] The EPC for lead was set at the arithmetic average.

Addendum Table 5
Data Evaluation and Selection of Chemicals of Potential Concern for Surface Soil (0- to 0.5-ft)
Area 3
Former CENCO Refinery
Santa Fe Springs, California

Constituent	Maximum Concentration [a] (mg/kg)	Site Soil Screening Level (Soil SLs) [b]			Background Level [c] (mg/kg)	Does Maximum Exceed Soil SL?		Is Constituent a Surface Soil COPC? [d] (YES, no)	
		Industrial Scenario (mg/kg)	Residential Scenario (mg/kg)	Surrogate		Industrial	Residential		
						(YES, no)	(YES, no)		
Volatile Organic Compounds (VOCs)									
1,1,1-Trichloroethane	3.80E-03	3.90E+04	9.00E+03		–	no	no	YES	
1,1,2-Trichloroethane	2.60E-03	5.50E+00	1.10E+00		–	no	no	YES	
1,2,4-Trichlorobenzene	1.70E-01	4.00E+02	8.70E+01		–	no	no	YES	
1,2,4-Trimethylbenzene	8.60E+00	2.80E+02	6.70E+01		–	no	no	YES	
1,2-Dichlorobenzene	2.90E+00	1.00E+04	2.00E+03		–	no	no	YES	
1,2-Dichloropropane	2.00E-02	4.70E+00	9.30E-01		–	no	no	YES	
1,3,5-Trimethylbenzene	5.30E+00	2.00E+02	4.70E+01		–	no	no	YES	
1,4-Dichlorobenzene	4.00E-01	1.30E+01	2.60E+00		–	no	no	YES	
2-Butanone	1.50E-01	1.90E+05	2.80E+04		–	no	no	no	
Acetone	2.60E-01	6.10E+05	6.10E+04		–	no	no	no	
Benzene	4.30E+00	5.60E+00	1.10E+00		–	no	YES	YES	
Bromodichloromethane	1.40E-01	4.60E+01	1.00E+01		–	no	no	YES	
c-1,2-Dichloroethene	1.90E-03	1.00E+04	7.80E+02		–	no	no	YES	
Carbon Disulfide	4.30E-02	3.00E+03	6.70E+02		–	no	no	YES	
Chloroform	2.60E-01	1.50E+00	3.00E-01		–	no	no	YES	
Ethylbenzene	3.00E+00	2.90E+01	5.70E+00		–	no	no	YES	
Isopropylbenzene	4.80E+00	1.10E+04	2.20E+03		–	no	no	YES	
Methylene Chloride	5.70E-01	5.40E+01	1.10E+01		–	no	no	YES	
Methyl-t-Butyl Ether (MTBE)	2.30E-01	1.90E+02	3.90E+01		–	no	no	YES	
n-Butylbenzene	3.80E+00	2.90E+01	5.70E+00	Ethylbenzene	–	no	no	YES	
n-Propylbenzene	6.20E+00	NA	NA		–	NA	NA	YES	
o-Xylene	6.20E+00	2.30E+04	5.30E+03		–	no	no	YES	
p/m-Xylene	8.20E+00	2.60E+03	6.00E+02	Xylenes mixture	–	no	no	YES	
p-Isopropyltoluene	2.10E+00	1.10E+04	2.20E+03	Isopropylbenzene	–	no	no	YES	
sec-Butylbenzene	5.20E+00	2.90E+01	5.70E+00	Ethylbenzene	–	no	no	YES	
Tert-Butyl Alcohol (TBA)	6.90E-01	3.10E+05	2.30E+04	Isobutyl Alcohol	–	no	no	YES	
tert-Butylbenzene	6.90E-01	2.90E+01	5.70E+00	Ethylbenzene	–	no	no	YES	
Tetrachloroethene	2.00E-03	2.70E+00	5.70E-01		–	no	no	YES	
Toluene	3.80E+00	4.60E+04	5.00E+03		–	no	no	YES	
Trichloroethene	2.60E-03	1.40E+01	2.80E+00		–	no	no	YES	
Xylenes, total	1.44E+01	2.60E+03	6.00E+02		–	no	no	YES	
Semivolatile Organic Compounds (SVOCs)									
1-Methylnaphthalene	7.60E+01	9.90E+01	2.20E+01		–	no	YES	YES	
2-Methylnaphthalene	7.20E+01	4.10E+03	3.10E+02		–	no	no	YES	
Acenaphthene	1.40E+01	3.30E+04	3.40E+03		–	no	no	YES	
Acenaphthylene	6.20E+00	3.30E+04	3.40E+03	Acenaphthene	–	no	no	YES	
Anthracene	7.30E+00	1.70E+05	1.70E+04		–	no	no	YES	
Benzo(a)anthracene	7.40E+00	2.10E+00	1.50E-01		–	YES	YES	YES	
Benzo(a)pyrene	5.10E+00	1.30E-01	1.50E-02		–	YES	YES	YES	
Benzo(b)fluoranthene	5.90E+00	2.10E+00	1.50E-01		–	YES	YES	YES	

Addendum Table 5
Data Evaluation and Selection of Chemicals of Potential Concern for Surface Soil (0- to 0.5-ft)
Area 3
Former CENCO Refinery
Santa Fe Springs, California

Constituent	Maximum Concentration [a] (mg/kg)	Site Soil Screening Level (Soil SLs) [b]			Surrogate	Background Level [c] (mg/kg)	Does Maximum Exceed Soil SL?		Is Constituent a Surface Soil COPC? [d] (YES, no)
		Industrial Scenario (mg/kg)	Residential Scenario (mg/kg)				Industrial	Residential	
							(YES, no)	(YES, no)	
Benzo(ghi)perylene	4.00E+00	1.70E+04	1.70E+03	Pyrene	—	no	no	no	YES
Benzo(k)fluoranthene	5.40E+00	2.10E+01	1.50E+00		—	no	no	YES	YES
Chrysene	7.50E+00	2.10E+02	1.50E+01		—	no	no	no	YES
Dibenzo(a,h)anthracene	3.50E+00	2.10E-01	1.50E-02		—	no	YES	YES	YES
Fluoranthene	1.50E+01	2.20E+04	2.30E+03		—	no	no	no	YES
Fluorene	2.20E+01	2.20E+04	2.30E+03		—	no	no	no	YES
Indeno(1,2,3-cd)pyrene	4.00E+00	2.10E+00	1.50E-01		—	no	YES	YES	YES
Naphthalene	4.30E+01	2.00E+01	3.90E+00		—	no	YES	YES	YES
Phenanthrene	1.20E+01	1.70E+05	1.70E+04	Anthracene	—	no	no	no	YES
Pyrene	1.30E+01	1.70E+04	1.70E+03		—	no	no	no	YES
Pesticides and Herbicides									
4,4-DDE	5.70E-03	5.10E+00	1.40E+00		—	no	no	no	YES
Polychlorinated Biphenyls (PCBs)									
Inorganic Compounds									
Antimony	1.42E+01	3.80E+02	3.00E+01		3.30E-01	no	no	no	YES
Arsenic	4.09E+01	2.40E-01	7.00E-02		1.30E+01	YES	YES	YES	
Barium	1.80E+03	6.30E+04	5.20E+03		5.33E+02	no	no	no	YES
Beryllium	8.87E-01	1.70E+03	1.50E+02		8.00E-01	no	no	no	YES
Cadmium	3.93E+00	7.50E+00	1.70E+00		1.60E-01	no	YES	YES	
Chromium	2.69E+03	1.40E+03	2.80E+02		3.50E+01	YES	YES	YES	
Chromium, Hexavalent	2.80E+00	3.70E+01	1.70E+01		—	no	no	no	YES
Cobalt	7.15E+01	3.00E+02	2.30E+01		6.90E+00	no	YES	YES	
Copper	1.37E+03	3.80E+04	3.00E+03		1.48E+01	no	no	no	YES
Lead	2.57E+04	8.00E+02	1.50E+02		1.42E+01	YES	YES	YES	
Mercury	2.76E+01	2.80E+01	6.70E+00		1.00E-01	no	YES	YES	
Molybdenum	6.79E+01	4.80E+03	3.80E+02		2.40E+00	no	no	YES	
Nickel	6.74E+01	1.60E+04	1.60E+03		1.90E+01	no	no	YES	
Selenium	3.22E+00	4.80E+03	3.80E+02		1.50E-01	no	no	YES	
Thallium	8.41E-01	6.30E+01	5.00E+00		—	no	no	no	YES
Vanadium	7.91E+01	6.70E+03	5.30E+02		6.00E+01	no	no	no	YES
Zinc	1.74E+03	1.00E+05	2.30E+04		1.70E+02	no	no	no	YES

— Not detected/ not analyzed/ not applicable.

CASN Chemical abstracts registry number.

COPC Constituent of Potential Concern

mg/kg Milligrams per kilogram.

NA Not available or not applicable.

[a] Maximum concentration in surface soil.

[b] See Table 3-2 for sources of soil screening levels.

[c] See Table 3-1 for sources of background values.

[d] All constituents were considered COPCs unless they were essential nutrients (i.e., calcium, magnesium, potassium, sodium), or they were known laboratory contaminants (i.e. acetone).

[e] Surface soil COPCs will be used for assessing exposure to the site worker receptor.

Addendum Table 6
Cumulative ILCR and HI for Onsite Commercial/Industrial Worker Receptor
Surface Soil (0-0.5 ft)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
Receptor Population: Site Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated				
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation			
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		HI	
Volatile Organic Compounds (VOCs)													
1,1,1-Trichloroethane	3.80E-03	m	2.17E+03	V	NA	NA	NA	NA	—	1.9E-09	—	4.0E-07	4.0E-07 <0.1%
1,1,2-Trichloroethane	2.60E-03	m	6.36E+03	V	6.5E-11	—	5.3E-10	6.0E-10	<0.1%	6.4E-07	—	NA	6.4E-07 <0.1%
1,2,2-Trichloropropane	—	—	1.14E+04	V	—	—	—	—	—	—	—	—	—
1,2,4-Trichlorobenzene	1.70E-01	m	4.23E+04	V	2.1E-10	—	NA	2.1E-10	<0.1%	1.7E-05	—	2.3E-04	2.5E-04 0.2%
1,2,4-Trimethylbenzene	6.82E-01	—	2.90E+04	V	NA	NA	NA	NA	—	NA	NA	7.7E-04	7.7E-04 0.6%
1,2-Dichlorobenzene	2.90E+00	m	1.43E+04	V	NA	NA	NA	NA	—	3.2E-05	—	2.3E-04	2.6E-04 0.2%
1,2-Dichloropropane	2.00E-02	m	3.52E+03	V	2.5E-10	—	4.6E-09	4.9E-09	<0.1%	NA	NA	3.2E-04	3.2E-04 0.3%
1,3,5-Trimethylbenzene	1.68E-01	—	1.15E+04	V	NA	NA	NA	NA	—	3.3E-06	—	5.5E-04	5.6E-04 0.5%
1,4-Dichlorobenzene	4.00E-01	m	1.28E+04	V	7.5E-10	—	2.8E-08	2.9E-08	<0.1%	NA	NA	9.0E-06	9.0E-06 <0.1%
Benzene	3.56E-01	—	2.68E+03	V	1.2E-08	—	3.1E-07	3.3E-07	0.6%	8.7E-05	—	5.0E-04	5.9E-04 0.5%
Bromodichloromethane	1.40E-01	m	8.10E+03	V	6.4E-09	—	5.2E-08	5.9E-08	0.1%	6.8E-06	—	NA	6.8E-06 <0.1%
c-1,2-Dichloroethene	1.90E-03	m	2.85E+03	V	NA	NA	NA	NA	—	1.9E-07	—	NA	1.9E-07 <0.1%
Carbon Disulfide	4.30E-02	m	1.17E+03	V	NA	NA	NA	NA	—	4.2E-07	—	1.0E-05	1.1E-05 <0.1%
Chloroform	1.32E-02	—	2.61E+03	V	1.4E-10	—	2.2E-09	2.3E-09	<0.1%	1.3E-06	—	3.9E-06	5.1E-06 <0.1%
Ethylbenzene	1.02E-01	—	5.29E+03	V	3.9E-10	—	3.9E-09	4.3E-09	<0.1%	9.9E-07	—	2.2E-06	3.2E-06 <0.1%
Iodomethane	—	—	1.32E+09	P	—	—	—	—	—	—	—	—	—
Isopropylbenzene	1.63E-01	—	1.65E+03	V	NA	NA	NA	NA	—	1.6E-06	—	5.6E-05	5.8E-05 <0.1%
Methylene Chloride	5.70E-01	m	2.45E+03	V	2.8E-09	—	1.9E-08	2.2E-08	<0.1%	9.3E-06	—	1.3E-04	1.4E-04 0.1%
Methyl-t-Butyl Ether (MTBE)	2.30E-01	m	4.07E+03	V	1.4E-10	—	1.2E-09	1.3E-09	<0.1%	NA	NA	1.6E-06	1.6E-06 <0.1%
n-Butylbenzene	1.66E-01	—	7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA
n-Propylbenzene	2.26E-01	—	6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA
o-Xylene	4.51E-01	—	5.16E+03	V	NA	NA	NA	NA	—	2.2E-07	—	2.9E-05	2.9E-05 <0.1%
p/m-Xylene	5.99E-01	—	3.79E+03	V	NA	NA	NA	NA	—	2.9E-06	—	3.6E-04	3.6E-04 0.3%
p-Isopropyltoluene	8.36E-02	—	8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA
sec-Butylbenzene	1.74E-01	—	7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA
t-1,2-Dichloroethene	—	—	2.28E+03	V	—	—	—	—	—	—	—	—	—
Tert-Butyl Alcohol (TBA)	4.34E-02	—	1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA
tert-Butylbenzene	6.90E-01	m	7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA
Tetrachloroethene	2.00E-03	m	2.50E+03	V	3.8E-10	—	3.8E-10	7.6E-10	<0.1%	2.0E-07	—	5.2E-06	5.4E-06 <0.1%
Toluene	3.87E-01	—	3.90E+03	V	NA	NA	NA	NA	—	4.7E-06	—	7.5E-05	8.0E-05 <0.1%
Trichloroethene	2.60E-03	m	3.20E+03	V	1.2E-11	—	1.3E-10	1.4E-10	<0.1%	NA	NA	3.1E-07	3.1E-07 <0.1%
Vinyl Chloride	—	—	1.02E+03	V	—	—	—	—	—	—	—	—	—
Xylenes, total	1.05E+00	—	4.39E+03	V	NA	NA	NA	NA	—	5.1E-06	—	7.8E-05	8.3E-05 <0.1%
Semivolatile Organic Compounds (SVOCs)													
1-Methylnaphthalene	4.95E+00	—	1.63E+05	V	5.0E-08	—	NA	5.0E-08	<0.1%	NA	NA	NA	—
2-Methylnaphthalene	4.98E+00	—	1.13E+05	V	NA	NA	NA	NA	—	1.2E-03	—	NA	1.2E-03 1.0%
Acenaphthene	6.97E-01	—	2.12E+05	V	NA	NA	NA	NA	—	1.1E-05	1.9E-05	NA	3.1E-05 <0.1%
Acenaphthylene	6.20E+00	m	1.63E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA
Anthracene	5.39E-01	—	7.70E+05	V	NA	NA	NA	NA	—	1.8E-06	3.0E-06	NA	4.8E-06 <0.1%

Addendum Table 6
Cumulative ILCR and HI for Onsite Commercial/Industrial Worker Receptor
Surface Soil (0-0.5 ft)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
Receptor Population: Site Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated				
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation			
Benzo(a)anthracene	5.53E-01	1.32E+09 P	2.3E-07	4.0E-07	3.8E-12	6.3E-07	1.2%	NA	NA	NA	NA	-	
Benzo(a)pyrene	3.03E-01	1.32E+09 P	1.3E-06	2.2E-06	2.1E-11	3.4E-06	6.5%	NA	NA	NA	NA	-	
Benzo(b)fluoranthene	3.38E-01	1.32E+09 P	1.4E-07	2.4E-07	2.3E-12	3.8E-07	0.7%	NA	NA	NA	NA	-	
Benzo(ghi)perylene	2.64E-01	1.32E+09 P	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Benzo(k)fluoranthene	4.34E-01	1.32E+09 P	1.8E-07	3.1E-07	3.0E-12	4.9E-07	0.9%	NA	NA	NA	NA	-	
Chrysene	6.65E-01	1.32E+09 P	2.8E-08	4.8E-08	4.5E-13	7.6E-08	0.1%	NA	NA	NA	NA	-	
Dibenzo(a,h)anthracene	3.50E+00 m	1.32E+09 P	5.0E-06	8.6E-06	2.6E-10	1.4E-05	25.5%	NA	NA	NA	NA	-	
Fluoranthene	7.62E-01	1.32E+09 P	NA	NA	NA	NA	-	1.9E-05	3.2E-05	NA	5.1E-05	<0.1%	
Fluorene	1.04E+00	5.02E+05 V	NA	NA	NA	NA	-	2.5E-05	4.3E-05	NA	6.9E-05	<0.1%	
Indeno(1,2,3-cd)pyrene	3.28E-01	1.32E+09 P	1.4E-07	2.4E-07	2.2E-12	3.7E-07	0.7%	NA	NA	NA	NA	-	
Naphthalene	1.42E+00	5.49E+04 V	NA	NA	7.2E-08	7.2E-08	0.1%	7.0E-05	1.2E-04	6.6E-04	8.4E-04	0.7%	
Phenanthrene	8.63E-01	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Pyrene	1.48E+00	1.32E+09 P	NA	NA	NA	NA	-	4.8E-05	8.3E-05	NA	1.3E-04	0.1%	
Pesticides and Herbicides													
4,4-DDE	5.70E-03 m	1.32E+09 P	6.8E-10	3.9E-10	3.4E-14	1.1E-09	<0.1%	NA	NA	NA	NA	-	
Aldrin	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
Chlordane	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
Dieldrin	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
Polychlorinated Biphenyls (PCBs)													
PCB-1254	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
PCB-1260	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
Inorganic Compounds													
Antimony	1.40E+00	1.32E+09 P	NA	NA	NA	NA	-	3.4E-03	-	NA	3.4E-03	2.8%	
Arsenic	7.60E+00	1.32E+09 P	2.5E-05	8.6E-06	1.6E-09	3.4E-05	63.2%	2.5E-02	8.5E-03	8.8E-05	3.3E-02	27.1%	
Barium	2.23E+02	1.32E+09 P	NA	NA	NA	NA	-	1.1E-03	-	7.7E-05	1.2E-03	0.9%	
Beryllium	5.37E-01	1.32E+09 P	NA	NA	8.0E-11	8.0E-11	<0.1%	2.6E-04	-	1.3E-05	2.8E-04	0.2%	
Cadmium	8.34E-01	1.32E+09 P	NA	NA	2.2E-10	2.2E-10	<0.1%	8.2E-04	3.7E-04	7.2E-06	1.2E-03	1.0%	
Chromium	2.04E+02	1.32E+09 P	NA	NA	NA	NA	-	1.3E-04	-	NA	1.3E-04	0.1%	
Chromium, Hexavalent	2.80E+00 m	1.32E+09 P	NA	NA	2.6E-08	2.6E-08	<0.1%	9.1E-04	-	2.4E-06	9.2E-04	0.7%	
Cobalt	1.29E+01	1.32E+09 P	NA	NA	7.2E-09	7.2E-09	<0.1%	4.2E-02	-	3.7E-04	4.2E-02	34.5%	
Copper	1.48E+02	1.32E+09 P	NA	NA	NA	NA	-	3.6E-03	-	NA	3.6E-03	2.9%	
Lead	4.06E+02	1.32E+09 P	NA	NA	3.0E-10	3.0E-10	<0.1%	NA	NA	NA	NA	-	
Mercury	2.74E+00	1.32E+09 P	NA	NA	NA	NA	-	8.9E-03	-	1.6E-05	9.0E-03	7.3%	
Molybdenum	6.74E+00	1.32E+09 P	NA	NA	NA	NA	-	1.3E-03	-	NA	1.3E-03	1.1%	
Nickel	2.28E+01	1.32E+09 P	NA	NA	3.7E-10	3.7E-10	<0.1%	1.1E-03	-	7.9E-05	1.2E-03	1.0%	
Selenium	9.43E-01	1.32E+09 P	NA	NA	NA	NA	-	1.8E-04	-	8.2E-09	1.8E-04	0.2%	
Silver	-	1.32E+09 P	-	-	-	-	-	-	-	-	-	-	
Thallium	8.41E-01 m	1.32E+09 P	NA	NA	NA	NA	-	1.3E-02	-	NA	1.3E-02	10.3%	

Addendum Table 6
Cumulative ILCR and HI for Onsite Commercial/Industrial Worker Receptor
Surface Soil (0-0.5 ft)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
Receptor Population: Site Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI		
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated					
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
Vanadium	3.82E+01	1.32E+09 P	NA	NA	NA	NA	–	5.3E-03	–	NA	5.3E-03	4.3%		
Zinc	2.56E+02	1.32E+09 P	NA	NA	NA	NA	–	8.4E-04	–	NA	8.4E-04	0.7%		
Total Risk or Hazard			Total ELCR			5E-05	100%	Total HI			0.1	100%		
Total Risk or Hazard from Arsenic						3E-05					0.03			
Total Risk or Hazard without Arsenic						2E-05					0.09			

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCR}_o = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCR}_d = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCR}_i = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQ}_o = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQ}_d = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQ}_i = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Addendum Table 7
Cumulative ILCRs and HIs for Direct Contact Soil Pathways
Commercial/Industrial Workers Using Revised Exposure Factors per DTSC Comment #7
Former CENCO Refinery
Santa Fe Springs, California

Area and Depth	Commercial/Industrial Worker				Construction Worker				Utility/Trench Worker			
	With Arsenic		Without Arsenic		With Arsenic		Without Arsenic		With Arsenic		Without Arsenic	
	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI	ILCR	HI
Area 1												
0 - 2 Feet	3E-05	0.1	6E-06	0.07	NA	NA	NA	NA	NA	NA	NA	NA
0 - 10 Feet	2E-05	0.2	4E-06	0.1	4E-06	1	1E-06	1	2E-06	0.09	7E-07	0.08
Area 2												
0 - 2 Feet	5E-05	0.2	2E-05	0.2	NA	NA	NA	NA	NA	NA	NA	NA
0 - 10 Feet	5E-05	0.5	1E-05	0.4	7E-06	3	2E-06	2	4E-06	0.2	1E-06	0.2
Area 3												
0 - 0.5 Feet*	5E-05	0.1	2E-05	0.09	NA	NA	NA	NA	NA	NA	NA	NA
0 - 2 Feet	5E-05	0.4	2E-05	0.4	NA	NA	NA	NA	NA	NA	NA	NA
0 - 10 Feet	4E-05	0.4	1E-05	0.4	6E-06	2	3E-06	1	3E-06	0.1	2E-06	0.1
Area 4												
0 - 2 Feet	4E-05	0.4	9E-06	0.3	NA	NA	NA	NA	NA	NA	NA	NA
0 - 10 Feet	3E-05	0.3	5E-06	0.3	5E-06	2	1E-06	1	3E-06	0.1	8E-07	0.1

NA: Not applicable; depth interval not addressed for this receptor.

*ILCR and HI based on 0- to 0.5-ft soil data set as per DTSC.

All ILCR and HI based on updated exposure factors (100 mg/day soil ingestion rate for commercial/industrial worker and 0.8 mg/cm² soil adherence rate for construction and utility workers, as per DTSC).

Addendum Table 8
Soil Matrix RBCs for Onsite Commercial/Industrial Worker Receptor

Baseline Human Health Risk Assessment
Former Cenco Refinery
Santa Fe Springs, California

Scenario Timeframe: [Current/Future](#)
Receptor Population: [Site Worker](#)
Receptor Age: [Adult](#)

Constituent*	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	UNIT CONC. BASED CANCER RISK				Target Risk Level	Risk-Based Conc. (mg/kg)		
			Route-Specific Unit Risk Based			Calculated Unit Risk				
			Oral	Dermal	Inhalation					
ELCRo	ELCRd	ELCRi	ELCR							
1,2,3-Trichloropropane	1.00E+00	1.14E+04 V	2.4E-06	—	NA	2.45E-06	1.0E-06	4.1E-01		
Benzene	1.00E+00	2.68E+03 V	3.5E-08	—	8.8E-07	9.16E-07	1.0E-06	1.1E+00		
Benzo(a)pyrene	1.00E+00	1.32E+09 P	4.2E-06	7.2E-06	6.8E-11	1.14E-05	1.0E-06	8.8E-02		
Dibenzo(ah)anthracene	1.00E+00	1.32E+09 P	1.4E-06	2.5E-06	7.4E-11	3.88E-06	1.0E-06	2.6E-01		
Aldrin	1.00E+00	1.32E+09 P	5.9E-06	3.4E-06	3.0E-10	9.33E-06	1.0E-06	1.1E-01		
Chlordane	1.00E+00	1.32E+09 P	4.5E-07	2.6E-07	2.1E-11	7.13E-07	1.0E-06	1.4E+00		
PCB-1254	1.00E+00	1.32E+09 P	7.0E-07	1.2E-06	3.5E-11	1.89E-06	1.0E-06	5.3E-01		
Arsenic	1.00E+00	1.32E+09 P	3.3E-06	1.1E-06	2.0E-10	4.43E-06	1.0E-06	2.3E-01		

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

*Constituent selected because its individual ELCR was greater than 1×10^6 in Area 1, 2, 3 or 4.

— = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

NA = not available

PEF = particulate emission factor

VF = volatilization factor

RBC = Risk-based concentration

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

RBC = Target risk level/Calculated unit risk-based ELCR

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

Addendum Table 9
Updated Risk Characterization Summary
Former CENCO Refinery
Santa Fe, California

Receptor	Area 1				Area 2				Area 3				Area 4			
	All Constituents		All Constituents Except Arsenic		All Constituents		All Constituents Except Arsenic		All Constituents		All Constituents Except Arsenic		All Constituents		All Constituents Except Arsenic	
	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI
Exposure Medium - Scenario																
Current																
Hypothetical Current Onsite Commercial/Industrial Worker Receptor ^a																
Hypothetical Current Offsite Child and Adult Resident Receptors																
Hypothetical Current Offsite Child Resident Receptor																
Airborne Particulate Inhalation (0-2 ft for Areas 1 through 3 and 0-0.5 ft for Area 4)	2E-08	0.002	2E-08	0.002	2E-08	0.007	1E-08	0.007	4E-08	0.003	3E-08	0.002	9E-09	0.003	8E-09	0.003
Hypothetical Current Offsite Adult Resident Receptor																
Airborne Particulate Inhalation (0-2 ft for Areas 1 through 3 and 0-0.5 ft for Area 4)	8E-08	0.002	7E-08	0.002	7E-08	0.007	6E-08	0.007	1E-07	0.003	1E-07	0.002	4E-08	0.003	3E-08	0.003
Total for Child/Adult	1E-07	0.002	9E-08	0.002	8E-08	0.007	7E-08	0.007	2E-07	0.003	2E-07	0.002	5E-08	0.003	4E-08	0.003
Current/Future																
Hypothetical Future Onsite Construction Worker Receptor ^b																
Direct Contact with Soil (0-10 ft)	4E-06	1	1E-06	1	7E-06	3	2E-06	2	6E-06	2	3E-06	1	5E-06	2	1E-06	1
Hypothetical Future Onsite Utility/Trench Worker Receptor ^b																
Direct Contact with Soil (0-10 ft)	2E-06	0.09	7E-07	0.08	4E-06	0.2	1E-06	0.2	3E-06	0.1	2E-06	0.1	3E-06	0.1	8E-07	0.1
Current/Future Commercial/Industrial Workers Using Revised Exposure Factors per DTSC Comment #7 ^c																
Direct Contact with Soil (0-0.5 ft)	NA	NA	NA	NA	NA	NA	NA	NA	5E-05	0.1	2E-05	0.09	NA	NA	NA	NA
Inhalation of Vapors Indoors ^d	NA	NA	NA	NA	NA	NA	NA	NA	5E-03	12.5	5E-03	12.5	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA	NA	NA	NA	6E-03	12.6	5E-03	12.6	NA	NA	NA	NA
Direct Contact with Soil (0-2 ft)	3E-05	0.1	6E-06	0.07	5E-05	0.2	2E-05	0.2	5E-05	0.4	2E-05	0.4	4E-05	0.4	9E-06	0.3
Inhalation of Vapors Indoors ^d	4E-03	19.7	4E-03	19.7	7E-03	11.1	7E-03	11.1	5E-03	12.5	5E-03	12.5	7E-03	11.7	7E-03	11.7
Total	4E-03	19.8	4E-03	19.7	7E-03	11.3	7E-03	11.3	6E-03	12.9	5E-03	12.9	7E-03	12.1	7E-03	12.0
Direct Contact with Soil (0-10 ft)	2E-05	0.2	4E-06	0.1	5E-05	0.5	1E-05	0.4	4E-05	0.4	1E-05	0.4	3E-05	0.3	5E-06	0.3
Inhalation of Vapors Indoors ^d	4E-03	19.7	4E-03	20	7E-03	11.1	7E-03	11.1	5E-03	12	5E-03	12.5	7E-03	11.7	7E-03	11.7
Total	4E-03	19.9	4E-03	19.8	7E-03	11.6	7E-03	11.5	5E-03	12.9	5E-03	12.9	7E-03	12.0	7E-03	12.0
Hypothetical Future Onsite Child and Adult Resident Receptors																
Hypothetical Future Onsite Child Resident Receptor																
Direct Contact with Soil (0-10 ft)	3E-05	0.9	4E-06	0.7	6E-05	2	1E-05	2	5E-05	2	2E-05	2	4E-05	2	5E-06	2
Direct Contact with Groundwater	1E-03	10	1E-03	10	1E-03	10	1E-03	10	1E-03	10	1E-03	10	1E-03	10	1E-03	10
Inhalation of Vapors Indoors	1E-06	0.01	1E-06	0.01	3E-07	0.0007	3E-07	0.0007	4E-07	0.003	4E-07	0.003	2E-06	0.006	2E-06	0.006
Total	1E-03	11	1E-03	11	1E-03	12	1E-03	12	1E-03	12	1E-03	12	1E-03	12	1E-03	12
Hypothetical Future Onsite Adult Resident Receptor																
Direct Contact with Soil (0-10 ft)	2E-05	0.3	5E-06	0.3	4E-05	0.4	2E-05	0.4	3E-05	0.3	1E-05	0.3	2E-05	0.4	8E-06	0.4
Direct Contact with Groundwater	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4
Inhalation of Vapors Indoors	1E-06	0.01	1E-06	0.01	3E-07	0.0007	3E-07	0.0007	4E-07	0.003	4E-07	0.003	2E-06	0.006	2E-06	0.006
Total	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4	2E-03	4
Total for Child/Adult	3E-03	11	3E-03	11	3E-03	12	3E-03	12	3E-03	12	3E-03	12	3E-03	12	3E-03	12

Shaded receptors were not updated; see text.

a: Same as future commercial/industrial worker (see non-shaded section).

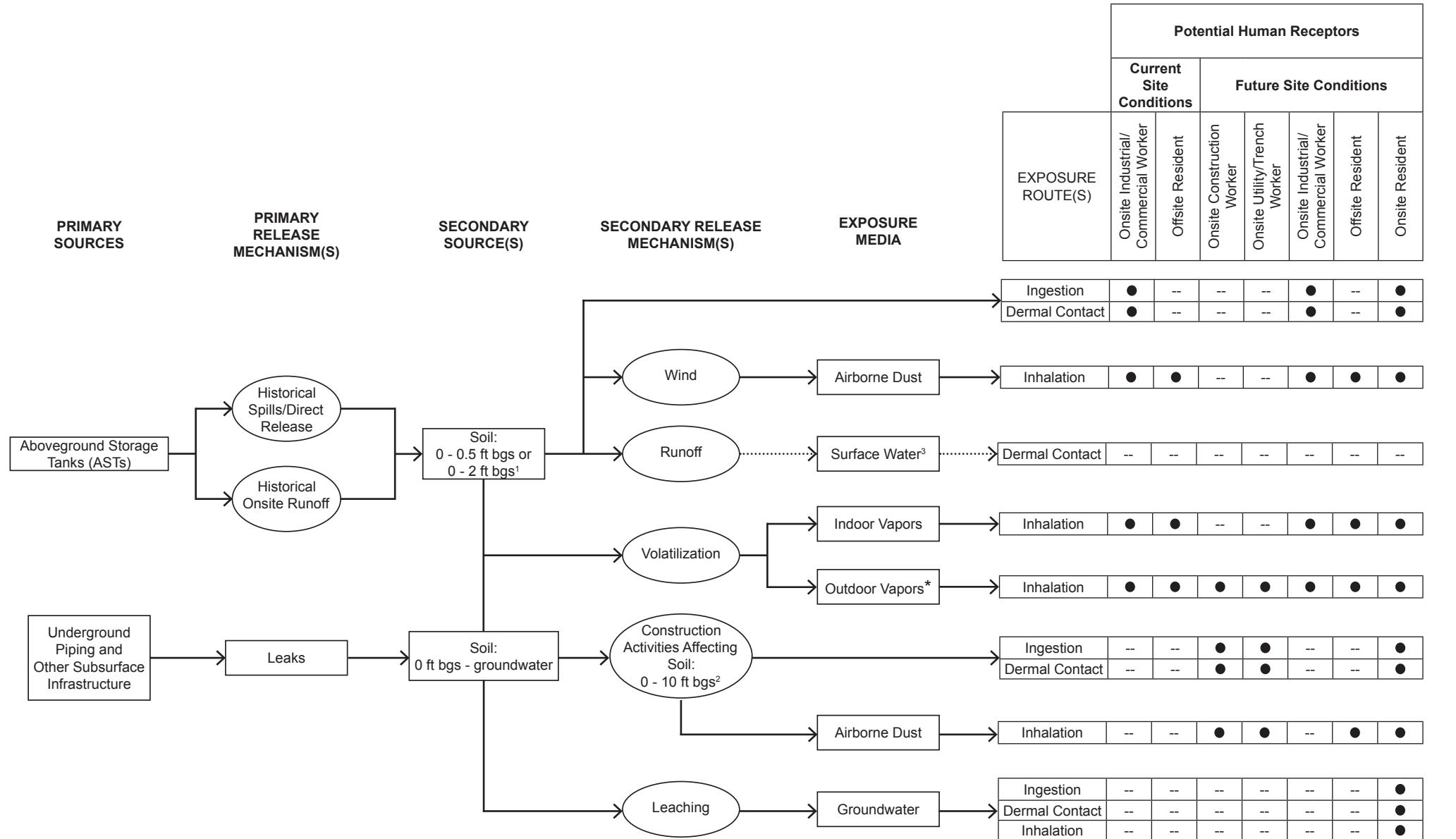
b: Inhalation of outdoor vapors was evaluated using soil matrix data and the chemical-specific VF; therefore, ELCR/HI for inhalation of vapors is included in the direct contact ELCR/HI.

c: For purposes of the addendum, this receptor was identified as current/future receptor worker for which ILCR/ELCR was revised per DTSC Comment #7

d: Maximum value by area for the 5 or 10 foot depth; see Addendum Table 3

ELCR: (Excess lifetime cancer risk) = ILCR (Incremental lifetime cancer risk).

NOTE: Screening HIs (e.g., as presented in this table) exceed target organ-specific HIs.



Notes:

→ = Potentially complete exposure pathway

● = Complete or potentially complete exposure pathway

bgs = below ground surface

.....→ = Potentially incomplete or insignificant exposure pathway/release mechanism

-- = Incomplete exposure pathway

BHHRA = baseline human health risk assessment

1 For all areas, the 0 to 0.5 ft and 0 to 2 ft bgs soil sample intervals were subject to a risk-based screening evaluation, and the soil sample interval reflecting the highest risk was conservatively used in the BHHRA.

2 Accounts for excavation activities down to 10 feet bgs and soil redistribution across the site during redevelopment/construction activities.

3 There is no surface water body related to refinery operations on the site.

* Risk assessment conservatively assumes 100% of exposure time is spent indoors for chronic receptors (industrial/commercial workers and residents).

FORMER CENCO REFINERY
SANTA FE SPRINGS, CALIFORNIA

BASELINE HUMAN HEALTH RISK ASSESSMENT

CONCEPTUAL SITE MODEL

ADDENDUM FIGURE 6-1

Appendix A

April 15, 2011
File Number **1003-001-200**

Department of Toxic Substance Control
5796 Corporate Avenue
Cypress, California 90630

Attention: **Mr. Steven Hariri, M.S., P.E.**
Senior Hazardous Substances Engineer

Subject: Response to Comments Regarding: DTSC Memo Dated January 10, 2011-
Comments to the *Baseline Human Health Risk Assessment, Former CENCO*
Refinery, Santa Fe Springs, California (Arcadis, 2009)

Dear Mr. Hariri:

Murex Environmental (Murex) has reviewed the Department of Toxic Substance Control's (DTSC) Human and Ecological Risk Office (HERO) comments on the Baseline Human Health Risk Assessment (HRA) (Arcadis, 2009) contained within the January 10, 2011 technical memorandum. As requested, this letter incorporates discussions held during the April 12, 2011 teleconference with DTSC and provides final comment responses that address the DTSC comments.

We understand that many of the discussed comments and comment responses will require revisions to HRA calculations, text, and/or tables. Murex proposes to address these revisions by creating an addendum document, rather than revising and re-submitting an entire HRA document. During the April 12, 2011 teleconference, DTSC agreed to this HRA revision approach and also requested that our draft response to comments incorporate the content and outcome of the April 12, 2011 teleconference. The remainder of this letter responds to that request. DTSC comments (shown in bold), followed by our review response, are listed below.

- 1. Section 5.1, Page 5-2: HERO agrees with the approach for selecting the data set for use in the evaluation of current site conditions (Appendix C) in general, except for the following: (a) lead should be evaluated separately as it is not part of the hazard quotient calculation; (b) For Area 3, both 0-0.5 ft and 0-2 ft data sets should be used in the BHHRA (the former has the higher**

total cancer risk while the latter has the higher total non-cancer hazard index); and (c) for future reference, HERO recommends using the maximum concentrations instead of the UCL concentrations as EPCs for the residential scenario (see the Comment on Section 6.5.1).

The HRA addendum will include (a) a separate evaluation for lead based on the current California Human Health Screening Level (CHHSL) and (b) inclusion of both the 0-0.5 ft-based exposure point concentration (EPC) and the 0-2 ft-based EPC.

Regarding the use of maximum concentrations as EPCs for the residential scenario, please see review response to DTSC Comment #5.

- 2. Section 5.2, Page 5-2: While the 5-ft-bgs data may be more representative of soil gas concentrations for assessing current conditions, HERO recommends discussing the effect of using the 10-ft-bgs data for chemicals that have the maximum concentration more than twice that at 5 ft bgs in the Uncertainties section.***

The HRA addendum will include a discussion of the effect of using the 10-ft soil gas data as the basis for indoor air exposures. This will be limited to chemicals for which the maximum 10 ft concentration is more than twice that of the 5 ft concentration.

- 3. Section 6.3.5, Page 6-4: Please include inhalation of vapors in ambient air (for volatile chemicals only) as one of the exposure pathways for soil in this section and Figure 6-1. This exposure route is relevant to all receptors spending time outdoors, and it is unclear whether it was evaluated for industrial/commercial workers and residents in the BHHRA.***

The HRA addendum will include a quantitative assessment of inhalation of vapors in ambient (outdoor) air.

- 4. Section 6.3.5, Page 6-4: As noted in this section, the only pathway for offsite receptors evaluated in the BHHRA is inhalation of airborne dust using onsite soil data. Therefore, HERO considers the assessment on offsite receptors incomplete and additional evaluation for other relevant pathways (e.g., indoor vapors) is required following collection of offsite data. For the time being, HERO recommends estimating potential risks associated with soil gas and groundwater using on-site data adjacent to those offsite properties that are currently occupied to determine if immediate action is warranted.***

The DTSC/RWQCB case managers recognize the need to consider off-site contamination; however this HRA was focused specifically on the on-site contaminants. Separately, a workplan to conduct off-site soil gas testing at adjacent properties was submitted to the agencies as ordered, and was approved on April 13, 2011. If the soil gas survey data can be collected in time to include this evaluation in the proposed Addendum, Lakeland will do so. Otherwise, this evaluation will be completed and submitted later in a separate submittal.

5. ***Section 6.5.1, Page 6-6: Please specify under what condition the maximum detected concentration was selected as the EPC (note that the attached CD for Appendix D does not contain the description of ProUCL). HERO does not consider the use of 95% UCL concentrations as EPCs appropriate for evaluating the residential scenario, considering the four areas evaluated range from 4.5 to 18.5 acres. If the site would be developed for residential use in the future, HERO recommends using the maximum concentrations to estimate upper-bound risks or refining the risk estimates (e.g., by location) to determine requirements for site cleanup.***

For datasets of less than 8 samples, the maximum soil concentration was used as the EPC. For datasets of 8 or more samples, a 95% UCL was used as the EPC. The HRA addendum will clarify this decision criterion.

In regard to the residential EPC, we note that using the maximum site-wide concentration (for each COPC, regardless of whether the maximums are co-located or not) as the basis for the residential EPC is consistent with a Tier 1 screening assessment. The HRA as currently written utilized a Tier 2 approach in that it used the 95% UCL for each COPC. This issue was discussed during our April 12, 2011 conference call during which DTSC furthered clarified their position that the maximum concentration or a point-by-point comparison to screening levels [California Human Health Screening Levels (CHHSLs)] should be used. However, in review of the site health risks documented in the HRA using the Tier 2 HRA methodology (EPCs are based on the 95% UCL for each of four evaluation areas), the residential scenario cancer risks exceed *de minimis* levels (e.g., 1×10^{-6} and/or a hazard index of 1 or greater) for all of the areas evaluated. Therefore, it can be concluded that a Tier 1 HRA, which assesses risks for smaller areas, would also exceed the *de minimis* benchmarks. As a consequence, the conclusions of the HRA would not change (i.e., remedial actions would be necessary for the residential scenario). Accordingly, we propose no additional Tier 1 analysis for purposes of the baseline HRA.

6. ***Section 6.5.1.2, Page 6-6: HERO does not agree with the use of 95% UCL concentrations as EPCs for soil gas in the indoor air evaluation. As stated in DTSC Interim Final Vapor Intrusion Guidance (2005), the maximum soil gas concentrations should be used for hypothetical/future buildings. Please provide justification for the soil parameter values used in the Johnson and Ettinger model (Appendix E), and those in the calculation of volatilization factors (Table 6-19).***

We agreed with the comment. The HRA addendum will include Johnson and Ettinger modeling for each relevant soil gas data point.

In regard to the soil parameter values used in the Johnson and Ettinger modeling, all model inputs were default values with the exception of chemical concentration and soil type, which was set at silty clay per site characteristics. This will be documented in the HRA addendum.

7. ***Section 6.5.2, Page 6-8: HERO has the following comments on the exposure parameters on Table 6-20: (a) for residents, the soil ingestion rate of 200 and 100 mg/day should be used for child and adult, respectively, in accordance with the DTSC (2005) and latest USEPA (e.g., RSL) guidance; (b) for commercial/industrial workers, the soil ingestion rate of 100 mg/day should be used to address outdoor workers; (c) for construction and utility trench workers, the soil adherence factor of 0.8 mg/cm²/day should be used in accordance with the DTSC (2005) guidance; and (d) HERO reviewed Reference [6] (CalEPA 2003), but could not verify the exposure duration of 7 years for utility trench workers; please provide additional information to substantiate the selection of this parameter value.***

Risks and hazard indices will be rerun in the HRA addendum using the exposure parameters listed above. In regard to the exposure duration of 7 years for utility trench workers, this value was selected as a conservative exposure duration for soil intrusive workers that may return to the site over time (as opposed to the construction worker receptor who has a default exposure duration of one year [USEPA, 2002]).

8. ***Section 6.5.3, Page 6-11: The Office of Environmental Health Hazard Office (OEHHA) recently revised the California Human Health Screening Level (CHHSL) for lead. (<http://www.oehha.ca.gov/risk/pdf/LeadCHHSL091709.pdf>). HERO recommends using the revised approach in the OEHHA document to***

evaluate residential and occupational exposures to lead (the same comment also applies to the discussion of lead in Section 6.7.3).

The HRA addendum will include a comparison of the lead data with the current CHHSLs.

9. Section 6.6.2, Page 6-13: Please specify which type (chronic or sub-chronic) of non-carcinogenic toxicity values was used to evaluate utility trench workers.

Subchronic toxicity criteria were used, where available for the utility trench worker scenario. This will be clarified in the HRA addendum.

10. The last sentence in the first bullet regarding conversion of RELs appears unnecessary and should be removed. Section 6.6.4, Page 6-14: While methane is not known to have major systemic toxicological effects to humans, its concentrations should be reviewed to ensure that they comply with the requirements by local agencies and do not pose explosion hazard.

We agree to this comment and will document this in the HRA addendum. Additionally, the HRA addendum will include a comparison of the methane data with the lower explosion and upper explosion limits.

11. Section 7, Page 7-1: HERO recommends clarifying the discussion in the first paragraph to specify the scenarios/receptors for the range of total estimated ELCRs (1x10-8 to 2x10-5). The total estimated ELCRs associated with non-residential exposures in Areas 2, 3, and 4 also do not match those on Table 6-26.

We agree with the first sentence of this comment. We independently cross-checked the ELCR, HI, and lead results summarized in Section with the values listed in Table 6-26 (ELCRs and HIs) and Table 6-27 (lead results). We found only two discrepancies:

- Area 2, Hypothetical Future Offsite Receptor – Table 6-26 lists HI as 0.006 but text lists 0.06.
- Area 4, Hypothetical Current Onsite Residential Receptor – Table 6-26 lists ELCR as 5E-08 but text lists 5E-07.

We did not find any discrepancies between Table 6-26 and the text for Area 3.

All final ELCR and HI results reported in the HRA addendum will be cross checked for accuracy.

12. Please note that some of the conclusions and recommended cleanup goals (Section 8) may need to be revised after incorporating the above comments.

We agree with this comment.

REFERENCES

Arcadis, 2009. Baseline Human Health Risk Assessment, Former CENCO Refinery, Santa Fe Springs, California, Sep. 17.

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http://www.dtsc.ca.gov/AssessingRisk/Supplemental_Guidance.cfm

CalEPA/DTSC, 1994. Preliminary Endangerment Assessment Guidance Manual. Department of Toxic Substances Control, January (second printing: June, 1999).
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USEPA, 1989. Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, December.
<http://www.epa.gov/oswer/riskassessment/ragsa/index.htm>

USEPA, 1992. Guidance for Data Usability in Risk Assessment (Part A), Final. Office of Emergency and Remedial Response, April.
<http://www.epa.gov/oswer/riskassessment/datause/partA.htm>

USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Solid Waste and Emergency Response, December.
<http://www.epa.gov/superfund/health/conmedia/soil/index.htm>

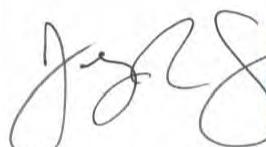
CLOSING

Should you have any questions or concerns regarding the material herein, please do not hesitate to contact the undersigned at (714) 508-0800.

Sincerely,
MUREX ENVIRONMENTAL, INC.



Teri L. Copeland, M.S., DABT
Toxicologist



Jeremy R. Squire, PE
Senior Engineer

Cc: State Water Quality Control Board, Los Angeles Region; Attn: Mr. Don Indermill
Lakeland Development Company; Attn: Mr. Mike Barranco
Isola Law Group; Attn: Mr. David Isola

Attachments: DTSC Memo Dated January 10, 2011- Comments to the *Baseline Human Health Risk Assessment, Former CENCO Refinery, Santa Fe Springs, California* (Arcadis, 2009)

Department of Toxic Substances Control



Linda S. Adams
Agency Secretary
Cal/EPA

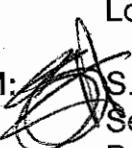
Maziar Movasaghi
Acting Director
5796 Corporate Avenue
Cypress, California 90630



Edmund G. Brown Jr.
Governor

MEMORANDUM

TO: Don Indermill, P.G.
Project Manager
Los Angeles Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

FROM:  S. Steven Hariri, M.S., P.E.
Senior Hazardous Substances Engineer
Department of Toxic Substances Control Board
Southern California Cleanup Operations Branch
5796 Corporate Avenue
Cypress, CA 90630

DATE: January 10, 2011

SUBJECT: REVIEW OF BASELINE HUMAN HEALTH RISK ASSESSMENT REPORT, FORMER CENCO REFINERY, SANTA FE SPRINGS, CA

PCA: 12020

SITE CODE: 301322-11

As requested, the Department of Toxics Substances Control (DTSC) Cypress Office Human and Ecological Risk Office (HERO) reviewed the Baseline Human Health Risk Assessment (BHHRA) report prepared by ARCADIS and dated September 2009. The following comments were developed and sent to you via email:

SPECIFIC COMMENTS

1. Section 5.1, Page 5-2: HERO agrees with the approach for selecting the data set for use in the evaluation of current site conditions (Appendix C) in general, except for the following: (a) lead should be evaluated separately as it is not part of the hazard quotient calculation; (b) For Area 3, both 0-0.5 ft and 0-2 ft data sets should be used in the BHHRA (the former has the higher total cancer risk while the latter has the higher total non-cancer hazard index); and (c) for future reference, HERO recommends using the maximum concentrations instead of the

UCL concentrations as EPCs for the residential scenario (see the Comment on Section 6.5.1).

2. Section 5.2, Page 5-2: While the 5-ft-bgs data may be more representative of soil gas concentrations for assessing current conditions, HERO recommends discussing the effect of using the 10-ft-bgs data for chemicals that have the maximum concentration more than twice that at 5 ft bgs in the Uncertainties section.
3. Section 6.3.5, Page 6-4: Please include inhalation of vapors in ambient air (for volatile chemicals only) as one of the exposure pathways for soil in this section and Figure 6-1. This exposure route is relevant to all receptors spending time outdoors, and it is unclear whether it was evaluated for industrial/commercial workers and residents in the BHHRA.
4. Section 6.3.5, Page 6-4: As noted in this section, the only pathway for offsite receptors evaluated in the BHHRA is inhalation of airborne dust using onsite soil data. Therefore, HERO considers the assessment on offsite receptors incomplete, and additional evaluation for other relevant pathways (e.g., indoor vapors) is required following collection of offsite data. For the time being, HERO recommends estimating potential risks associated with soil gas and groundwater using on-site data adjacent to those offsite properties that are currently occupied to determine if immediate action is warranted.
5. Section 6.5.1, Page 6-6: Please specify under what condition the maximum detected concentration was selected as the EPC (note that the attached CD for Appendix D does not contain the description of ProUCL). HERO does not consider the use of 95% UCL concentrations as EPCs appropriate for evaluating the residential scenario, considering the four areas evaluated range from 4.5 to 18.5 acres. If the site would be developed for residential use in the future, HERO recommends using the maximum concentrations to estimate upper-bound risks or refining the risk estimates (e.g., by location) to determine requirements for site cleanup.
6. Section 6.5.1.2, Page 6-6: HERO does not agree with the use of 95% UCL concentrations as EPCs for soil gas in the indoor air evaluation. As stated in DTSC Interim Final Vapor Intrusion Guidance (2005), the maximum soil gas concentrations should be used for hypothetical/future buildings. Please provide justification for the soil parameter values used in the Johnson and Ettinger model (Appendix E), and those in the calculation of volatilization factors (Table 6-19).

7. Section 6.5.2, Page 6-8: HERO has the following comments on the exposure parameters on Table 6-20: (a) for residents, the soil ingestion rate of 200 and 100 mg/day should be used for child and adult, respectively, in accordance with the DTSC (2005) and latest USEPA (e.g., RSL) guidance; (b) for commercial/industrial workers, the soil ingestion rate of 100 mg/day should be used to address outdoor workers; (c) for construction and utility trench workers, the soil adherence factor of 0.8 mg/cm²/day should be used in accordance with the DTSC (2005) guidance; and (d) HERO reviewed Reference [6] (CalEPA 2003), but could not verify the exposure duration of 7 years for utility trench workers; please provide additional information to substantiate the selection of this parameter value.
8. Section 6.5.3, Page 6-11: The Office of Environmental Health Hazard Office (OEHHA) recently revised the California Human Health Screening Level (CHHSL) for lead (<http://www.oehha.ca.gov/risk/pdf/LeadCHHSL091709.pdf>). HERO recommends using the revised approach in the OEHHA document to evaluate residential and occupational exposures to lead (the same comment also applies to the discussion of lead in Section 6.7.3).
9. Section 6.6.2, Page 6-13: Please specify which type (chronic or subchronic) of noncarcinogenic toxicity values was used to evaluate utility trench workers. The last sentence in the first bullet regarding conversion of RELs appears unnecessary and should be removed.
10. Section 6.6.4, Page 6-14: While methane is not known to have major systemic toxicological effects to humans, its concentrations should be reviewed to ensure that they comply with the requirements by local agencies and do not pose explosion hazard.
11. Section 7, Page 7-1: HERO recommends clarifying the discussion in the first paragraph to specify the scenarios/receptors for the range of total estimated ELCRs (1x10⁻⁸ to 2x10⁻⁵). The total estimated ELCRs associated with non-residential exposures in Areas 2, 3, and 4 also do not match those on Table 6-26. Please note that some of the conclusions and recommended cleanup goals (Section 8) may need to be revised after incorporating the above comments.

Appendix B

Appendix C

Appendix D

Revised Table F1
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
Volatile Organic Compounds (VOCs)														
1,1,2,2-Tetrachloroethane	1.20E-02	m	1.38E+04	V	1.1E-09	—	4.1E-09	5.2E-09	<0.1%	2.9E-06	—	NA	2.9E-06	<0.1%
1,1,2-Trichloroethane	7.70E-03	m	6.36E+03	V	1.9E-10	—	1.6E-09	1.8E-09	<0.1%	1.9E-06	—	NA	1.9E-06	<0.1%
1,2,3-Trichlorobenzene	9.00E-03	m	1.93E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
1,2,4-Trimethylbenzene	2.16E+00		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	NA	2.4E-03	2.4E-03
1,2-Dichloropropane	2.10E-03	m	3.52E+03	V	2.6E-11	—	4.9E-10	5.1E-10	<0.1%	NA	NA	NA	3.4E-05	3.4E-05
1,3,5-Trimethylbenzene	7.49E-01		1.15E+04	V	NA	NA	NA	NA	—	1.5E-05	—	2.5E-03	2.5E-03	2.6%
2-Chlorotoluene	2.80E-03	m	1.30E+04	V	NA	NA	NA	NA	—	1.4E-07	—	NA	1.4E-07	<0.1%
4-Chlorotoluene	2.10E-03	m	7.18E+03	V	NA	NA	NA	NA	—	2.9E-08	—	NA	2.9E-08	<0.1%
4-Methyl-2-Pentanone	1.20E-02	m	1.14E+04	V	NA	NA	NA	NA	—	1.5E-07	—	8.0E-08	2.3E-07	<0.1%
Benzene	1.77E-02		2.68E+03	V	6.2E-10	—	1.6E-08	1.6E-08	<0.1%	4.3E-06	—	2.5E-05	3.0E-05	<0.1%
Carbon Disulfide	3.40E-02	m	1.17E+03	V	NA	NA	NA	NA	—	3.3E-07	—	8.3E-06	8.6E-06	<0.1%
Ethylbenzene	1.45E-01		5.29E+03	V	5.6E-10	—	5.6E-09	6.1E-09	<0.1%	1.4E-06	—	3.1E-06	4.5E-06	<0.1%
Isopropylbenzene	3.55E-01		1.65E+03	V	NA	NA	NA	NA	—	3.5E-06	—	1.2E-04	1.3E-04	0.1%
Methyl-t-Butyl Ether (MTBE)	1.03E-02		4.07E+03	V	6.5E-12	—	5.4E-11	6.0E-11	<0.1%	NA	NA	7.2E-08	7.2E-08	<0.1%
n-Butylbenzene	3.99E-01		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
n-Propylbenzene	5.77E-01		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
o-Xylene	2.02E-01		5.16E+03	V	NA	NA	NA	NA	—	9.9E-08	—	1.3E-05	1.3E-05	<0.1%
p/m-Xylene	4.96E-01		3.79E+03	V	NA	NA	NA	NA	—	2.4E-06	—	3.0E-04	3.0E-04	0.3%
p-Isopropyltoluene	9.39E-02		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
sec-Butylbenzene	2.02E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Tert-Butyl Alcohol (TBA)	1.37E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Toluene	9.52E-02		3.90E+03	V	NA	NA	NA	NA	—	1.2E-06	—	1.9E-05	2.0E-05	<0.1%
Xylenes, total	6.82E-01		4.39E+03	V	NA	NA	NA	NA	—	3.3E-06	—	5.1E-05	5.4E-05	<0.1%
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	1.90E+01		1.63E+05	V	1.9E-07	—	NA	1.9E-07	0.6%	NA	NA	NA	NA	—
2-Methylnaphthalene	2.40E+01		1.13E+05	V	NA	NA	NA	NA	—	5.9E-03	—	NA	5.9E-03	6.2%
Acenaphthene	2.50E+00		2.12E+05	V	NA	NA	NA	NA	—	4.1E-05	7.0E-05	NA	1.1E-04	0.1%
Acenaphthylene	1.27E-01		1.63E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Anthracene	2.26E-01		7.70E+05	V	NA	NA	NA	NA	—	7.4E-07	1.3E-06	NA	2.0E-06	<0.1%
Benzo(a)anthracene	7.27E-01		1.32E+09	V	3.0E-07	5.2E-07	4.9E-12	8.3E-07	2.8%	NA	NA	NA	NA	—
Benzo(a)pyrene	3.12E-01		1.32E+09	V	1.3E-06	2.2E-06	2.1E-11	3.6E-06	11.8%	NA	NA	NA	NA	—

Revised Table F1
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					ELCR	HQo	HQd	HQi			
			Oral	Dermal	Inhalation									
			ELCRo	ELCRd	ELCRI	ELCR								
Benzo(b)fluoranthene	2.00E-01	1.32E+09	V	8.4E-08	1.4E-07	1.4E-12	2.3E-07	0.8%	NA	NA	NA	NA		
Benzo(ghi)perylene	1.56E-01	1.32E+09	V	NA	NA	NA	NA	—	NA	NA	NA	NA		
Benzo(k)fluoranthene	1.25E-01	1.32E+09	V	5.2E-08	8.9E-08	8.5E-13	1.4E-07	0.5%	NA	NA	NA	NA		
Chrysene	1.92E+00	1.32E+09	V	8.1E-08	1.4E-07	1.3E-12	2.2E-07	0.7%	NA	NA	NA	NA		
Dibenzo(a,h)anthracene	8.40E-02	1.32E+09	V	1.2E-07	2.1E-07	6.2E-12	3.3E-07	1.1%	NA	NA	NA	NA		
Fluoranthene	3.21E-01	1.32E+09	V	NA	NA	NA	NA	—	7.8E-06	1.3E-05	NA	2.1E-05		
Fluorene	2.59E+00	5.02E+05	V	NA	NA	NA	NA	—	6.3E-05	1.1E-04	NA	1.7E-04		
Indeno(1,2,3-cd)pyrene	9.28E-02	1.32E+09	V	3.9E-08	6.7E-08	6.3E-13	1.1E-07	0.4%	NA	NA	NA	NA		
Naphthalene	1.03E+00	5.49E+04	V	NA	NA	5.2E-08	5.2E-08	0.2%	5.0E-05	8.6E-05	4.8E-04	6.1E-04		
Phenanthrene	6.50E+00	9.92E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA		
Pyrene	3.87E+00	1.32E+09	V	NA	NA	NA	NA	—	1.3E-04	2.2E-04	NA	3.4E-04		
Inorganic Compounds														
Antimony	1.29E+00	1.32E+09	V	NA	NA	NA	NA	—	3.2E-03	—	NA	3.2E-03		
Arsenic	5.48E+00	1.32E+09	V	1.8E-05	6.2E-06	1.1E-09	2.4E-05	81.0%	1.8E-02	6.1E-03	6.3E-05	2.4E-02		
Barium	2.03E+02	1.32E+09	V	NA	NA	NA	NA	—	9.9E-04	—	7.0E-05	1.1E-03		
Beryllium	5.77E-01	1.32E+09	V	NA	NA	8.6E-11	8.6E-11	<0.1%	2.8E-04	—	1.4E-05	3.0E-04		
Cadmium	7.52E-01	1.32E+09	V	NA	NA	2.0E-10	2.0E-10	<0.1%	7.4E-04	3.4E-04	6.5E-06	1.1E-03		
Chromium	7.16E+01	1.32E+09	V	NA	NA	NA	NA	—	4.7E-05	—	NA	4.7E-05		
Chromium, Hexavalent	1.20E+00	m	1.32E+09	V	NA	NA	1.1E-08	1.1E-08	<0.1%	3.9E-04	—	1.0E-06		
Cobalt	1.18E+01	1.32E+09	V	NA	NA	6.5E-09	6.5E-09	<0.1%	3.8E-02	—	3.4E-04	3.9E-02		
Copper	1.36E+02	1.32E+09	V	NA	NA	NA	NA	—	3.3E-03	—	NA	3.3E-03		
Lead	2.17E+02	1.32E+09	V	NA	NA	1.6E-10	1.6E-10	<0.1%	NA	NA	NA	NA		
Mercury	2.46E-01	1.32E+09	V	NA	NA	NA	NA	—	8.0E-04	—	1.4E-06	8.0E-04		
Molybdenum	8.64E+00	1.32E+09	V	NA	NA	NA	NA	—	1.7E-03	—	NA	1.7E-03		
Nickel	1.95E+01	1.32E+09	V	NA	NA	3.1E-10	3.1E-10	<0.1%	9.5E-04	—	6.8E-05	1.0E-03		
Selenium	1.08E+00	1.32E+09	V	NA	NA	NA	NA	—	2.1E-04	—	9.4E-09	2.1E-04		
Vanadium	4.08E+01	1.32E+09	V	NA	NA	NA	NA	—	5.7E-03	—	NA	5.7E-03		
Zinc	2.51E+02	1.32E+09	V	NA	NA	NA	NA	—	8.2E-04	—	NA	8.2E-04		

Revised Table F1
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	ELCR	NON-CANCER HAZARD INDEX			Percent Hazard Index	
			Route-Specific Risk					Total	Route-Specific Hazard Quotient	Calculated Hazard Index		
			Oral	Dermal	Inhalation			ELCR	HQo	HQd	HQi	
			ELCRo	ELCRd	ELCRI						HI	
Total Risk or Hazard			Total	ELCR		3E-05	100%		Total	HI	0.1	100%
Total Risk or Hazard from Arsenic						2E-05					0.02	
Total Risk or Hazard without Arsenic						6E-06					0.07	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F-4
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Percent Hazard Index			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,1,2,2-Tetrachloroethane	1.20E-02	m	1.38E+04	V	1.5E-10	—	1.6E-10	3.1E-10	<0.1%	9.7E-06	—	NA	9.7E-06	<0.1%
1,1,2-Trichloroethane	7.70E-03	m	6.36E+03	V	2.6E-11	—	6.3E-11	8.9E-11	<0.1%	6.2E-07	—	NA	6.2E-07	<0.1%
1,2,3-Trichlorobenzene	9.00E-03	m	1.93E+05	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
1,2,4-Trichlorobenzene	4.63E-03	m	4.23E+04	V	7.7E-13	—	NA	7.7E-13	<0.1%	1.5E-06	—	1.2E-08	1.5E-06	<0.1%
1,2,4-Trimethylbenzene	1.54E+01		2.90E+04	V	NA	NA	NA	—	—	NA	NA	1.7E-02	1.7E-02	1.6%
1,2-Dichloropropane	2.10E-03	m	3.52E+03	V	3.5E-12	—	1.9E-11	2.3E-11	<0.1%	NA	NA	1.0E-05	1.0E-05	<0.1%
1,3,5-Trimethylbenzene	6.51E+00		1.15E+04	V	NA	NA	NA	—	—	4.2E-04	—	2.2E-02	2.2E-02	2.0%
2-Chlorotoluene	2.80E-03	m	1.30E+04	V	NA	NA	NA	—	—	4.5E-08	—	NA	4.5E-08	<0.1%
2-Hexanone	3.13E-03	m	1.53E+04	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
4-Chlorotoluene	2.10E-03	m	7.18E+03	V	NA	NA	NA	—	—	9.7E-08	—	NA	9.7E-08	<0.1%
4-Methyl-2-Pentanone	1.20E-02	m	1.14E+04	V	NA	NA	NA	—	—	4.8E-07	—	8.0E-08	5.6E-07	<0.1%
Benzene	4.70E-01		2.68E+03	V	2.2E-09	—	1.7E-08	1.9E-08	0.4%	1.3E-04	—	6.7E-04	7.9E-04	<0.1%
Carbon Disulfide	9.45E-03		1.17E+03	V	NA	NA	NA	—	—	3.1E-07	—	2.3E-06	2.6E-06	<0.1%
Chloroethane	6.50E-03	m	8.86E+02	V	NA	NA	NA	—	—	NA	NA	5.6E-08	5.6E-08	<0.1%
Chloromethane	2.13E-03	m	1.55E+03	V	1.3E-12	—	8.0E-12	9.3E-12	<0.1%	NA	NA	3.5E-07	3.5E-07	<0.1%
Ethylbenzene	3.32E+00		5.29E+03	V	1.7E-09	—	5.1E-09	6.8E-09	0.2%	1.1E-05	—	7.2E-05	8.2E-05	<0.1%
Iodomethane	1.38E-02	m	1.00E+06	P	NA	NA	NA	—	—	NA	NA	NA	NA	—
Isopropylbenzene	3.13E-01		1.65E+03	V	NA	NA	NA	—	—	2.5E-06	—	1.1E-04	1.1E-04	<0.1%
Methyl-t-Butyl Ether (MTBE)	6.74E-03		4.07E+03	V	5.6E-13	—	1.4E-12	2.0E-12	<0.1%	NA	NA	4.7E-08	4.7E-08	<0.1%
n-Butylbenzene	1.32E+00		7.83E+03	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
n-Propylbenzene	1.91E+00		6.62E+03	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
o-Xylene	7.70E+00		5.16E+03	V	NA	NA	NA	—	—	1.2E-05	—	4.9E-04	5.0E-04	<0.1%
p/m-Xylene	1.50E+01		3.79E+03	V	NA	NA	NA	—	—	2.4E-04	—	3.0E-03	3.3E-03	0.3%
p-Isopropyltoluene	6.99E-02		8.17E+03	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
sec-Butylbenzene	1.48E-01		7.06E+03	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
Tert-Butyl Alcohol (TBA)	4.30E-02		1.95E+04	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
tert-Butylbenzene	1.46E-01	m	7.06E+03	V	NA	NA	NA	—	—	NA	NA	NA	NA	—
Toluene	3.46E+00		3.90E+03	V	NA	NA	NA	—	—	1.4E-05	—	6.8E-04	6.9E-04	<0.1%
Xylenes, total	2.26E+01		4.39E+03	V	NA	NA	NA	—	—	3.6E-04	—	1.7E-03	2.0E-03	0.2%
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.22E+01		1.63E+05	V	3.0E-08	—	NA	3.0E-08	0.7%	NA	NA	NA	NA	—
2-Methylnaphthalene	3.72E+01		1.13E+05	V	NA	NA	NA	—	—	3.0E-02	—	NA	3.0E-02	2.7%
Acenaphthene	1.24E+00		2.12E+05	V	NA	NA	NA	—	—	6.7E-06	1.4E-05	NA	2.1E-05	<0.1%

Revised Table F-4
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Acenaphthylene	1.02E-01	1.63E+05	V	NA	NA	NA	—	NA	NA	NA	NA			
Anthracene	1.49E-01	7.70E+05	V	NA	NA	NA	—	1.6E-07	3.3E-07	NA	4.9E-07 <0.1%			
Benzo(a)anthracene	3.04E-01	1.00E+06	P	1.7E-08	3.5E-08	1.1E-10	5.2E-08	1.2%	NA	NA	NA			
Benzo(a)pyrene	1.44E-01	1.00E+06	P	8.0E-08	1.7E-07	5.2E-10	2.5E-07	5.8%	NA	NA	NA			
Benzo(b)fluoranthene	9.40E-02	1.00E+06	P	5.2E-09	1.1E-08	3.4E-11	1.6E-08	0.4%	NA	NA	NA			
Benzo(ghi)perylene	8.15E-02	1.00E+06	P	NA	NA	NA	—	NA	NA	NA	NA			
Benzo(k)fluoranthene	6.03E-02	1.00E+06	P	3.3E-09	6.9E-09	2.2E-11	1.0E-08	0.2%	NA	NA	NA			
Chrysene	6.53E-01	1.00E+06	P	3.6E-09	7.5E-09	2.3E-11	1.1E-08	0.3%	NA	NA	NA			
Dibenz(a,h)anthracene	6.70E-02	1.00E+06	P	1.3E-08	2.6E-08	2.6E-10	3.9E-08	0.9%	NA	NA	NA			
Fluoranthene	2.37E-01	1.00E+06	P	NA	NA	NA	—	1.9E-06	4.0E-06	NA	5.9E-06 <0.1%			
Fluorene	1.80E+00	5.02E+05	V	NA	NA	NA	—	1.5E-05	3.0E-05	NA	4.5E-05 <0.1%			
Indeno(1,2,3-cd)pyrene	5.03E-02	1.00E+06	P	2.8E-09	5.8E-09	1.8E-11	8.6E-09	0.2%	NA	NA	NA			
Naphthalene	5.06E+00	5.49E+04	V	NA	NA	1.0E-08	1.0E-08	0.2%	8.2E-05	1.7E-04	2.3E-03			
Phenanthrene	4.47E+00	9.92E+05	V	NA	NA	NA	—	NA	NA	NA	NA			
Pyrene	1.32E+00	1.00E+06	P	NA	NA	NA	—	1.4E-05	2.9E-05	NA	4.4E-05 <0.1%			
Polychlorinated Biphenyls (PCBs)														
PCB-1254	5.00E-02	m	1.00E+06	P	4.6E-09	9.6E-09	9.3E-11	1.4E-08	0.3%	3.2E-03	6.7E-03	NA 9.9E-03 0.9%		
PCB-1260	4.00E-02	m	1.00E+06	P	3.7E-09	7.6E-09	7.4E-11	1.1E-08	0.3%	NA	NA	NA		
Inorganic Compounds														
Antimony	2.29E+00	1.00E+06	P	NA	NA	NA	—	1.8E-02	—	NA	1.8E-02 1.7%			
Arsenic	4.75E+00	1.00E+06	P	2.1E-06	8.6E-07	5.1E-08	3.0E-06	70.2%	5.1E-02	2.1E-02	7.2E-02 1.4E-01 13.2%			
Barium	1.93E+02	1.00E+06	P	NA	NA	NA	—	3.1E-03	—	8.8E-03	1.2E-02 1.1%			
Beryllium	7.96E-01	1.00E+06	P	NA	NA	6.2E-09	6.2E-09	0.1%	5.1E-04	—	2.6E-02 2.6E-02 2.4%			
Cadmium	4.96E-01	1.00E+06	P	NA	NA	6.8E-09	6.8E-09	0.2%	1.6E-03	8.9E-04	5.7E-03 8.1E-03 0.7%			
Chromium	5.91E+01	1.00E+06	P	NA	NA	NA	—	1.3E-04	—	NA	1.3E-04 <0.1%			
Chromium, Hexavalent	7.28E-01	1.00E+06	P	NA	NA	3.6E-07	3.6E-07	8.4%	1.2E-04	—	8.3E-04 9.5E-04 <0.1%			
Cobalt	1.35E+01	1.00E+06	P	NA	NA	4.0E-07	4.0E-07	9.3%	1.5E-01	—	5.1E-01 6.6E-01 60.1%			
Copper	7.33E+01	1.00E+06	P	NA	NA	NA	—	5.9E-03	—	NA	5.9E-03 0.5%			
Lead	1.45E+02	1.00E+06	P	NA	NA	5.7E-09	5.7E-09	0.1%	NA	NA	NA			
Mercury	1.78E-01	1.00E+06	P	NA	NA	NA	—	1.9E-03	—	1.4E-03	3.3E-03 0.3%			
Molybdenum	3.52E+00	1.00E+06	P	NA	NA	NA	—	2.3E-03	—	NA	2.3E-03 0.2%			
Nickel	2.14E+01	1.00E+06	P	NA	NA	1.8E-08	1.8E-08	0.4%	3.5E-03	—	9.8E-02 1.0E-01 9.2%			
Selenium	1.06E+00	1.00E+06	P	NA	NA	NA	—	6.8E-04	—	1.2E-05	6.9E-04 <0.1%			
Vanadium	4.92E+01	1.00E+06	P	NA	NA	NA	—	2.3E-02	—	NA	2.3E-02 2.1%			

Revised Table F-4
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	
Zinc	1.89E+02	1.00E+06 P	NA	NA	NA	NA	–	2.0E-03	–	NA	2.0E-03 0.2%
Total Risk or Hazard			Total ELCR			4E-06	100%	Total HI			1 100%
Total Risk or Hazard from Arsenic						3E-06					0.1
Total Risk or Hazard without Arsenic						1E-06					1

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 250 \times 1 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1) / ([\text{VF or PEF}] \times 365 \times \text{RfC})$$

Revised Table F-5
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI					
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index							
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation						
ELCRo ELCRd ELCRI ELCR HQo HQd HQi HI																
Volatile Organic Compounds (VOCs)																
1,1,2,2-Tetrachloroethane	1.20E-02	m	1.38E+04	V	8.4E-11	—	9.2E-11	1.8E-10	<0.1%	7.7E-07	—	NA	7.7E-07	<0.1%		
1,1,2-Trichloroethane	7.70E-03	m	6.36E+03	V	1.4E-11	—	3.5E-11	5.0E-11	<0.1%	5.0E-08	—	NA	5.0E-08	<0.1%		
1,2,3-Trichlorobenzene	9.00E-03	m	1.93E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
1,2,4-Trichlorobenzene	4.63E-03	m	4.23E+04	V	4.3E-13	—	NA	4.3E-13	<0.1%	1.2E-07	—	1.0E-09	1.2E-07	<0.1%		
1,2,4-Trimethylbenzene	1.54E+01		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	1.4E-03	1.4E-03	1.6%		
1,2-Dichloropropane	2.10E-03	m	3.52E+03	V	2.0E-12	—	1.1E-11	1.3E-11	<0.1%	NA	NA	8.4E-07	8.4E-07	<0.1%		
1,3,5-Trimethylbenzene	6.51E+00		1.15E+04	V	NA	NA	NA	NA	—	3.4E-05	—	1.7E-03	1.8E-03	2.0%		
2-Chlorotoluene	2.80E-03	m	1.30E+04	V	NA	NA	NA	NA	—	3.6E-09	—	NA	3.6E-09	<0.1%		
2-Hexanone	3.13E-03	m	1.53E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
4-Chlorotoluene	2.10E-03	m	7.18E+03	V	NA	NA	NA	NA	—	7.7E-09	—	NA	7.7E-09	<0.1%		
4-Methyl-2-Pentanone	1.20E-02	m	1.14E+04	V	NA	NA	NA	NA	—	3.9E-08	—	6.4E-09	4.5E-08	<0.1%		
Benzene	4.70E-01		2.68E+03	V	1.2E-09	—	9.3E-09	1.0E-08	0.4%	1.0E-05	—	5.3E-05	6.3E-05	<0.1%		
Carbon Disulfide	9.45E-03		1.17E+03	V	NA	NA	NA	NA	—	2.4E-08	—	1.8E-07	2.1E-07	<0.1%		
Chloroethane	6.50E-03	m	8.86E+02	V	NA	NA	NA	NA	—	NA	NA	4.5E-09	4.5E-09	<0.1%		
Chloromethane	2.13E-03	m	1.55E+03	V	7.1E-13	—	4.5E-12	5.2E-12	<0.1%	NA	NA	2.8E-08	2.8E-08	<0.1%		
Ethylbenzene	3.32E+00		5.29E+03	V	9.4E-10	—	2.9E-09	3.8E-09	0.2%	8.6E-07	—	5.7E-06	6.6E-06	<0.1%		
Iodomethane	1.38E-02	m	1.00E+06	P	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
Isopropylbenzene	3.13E-01		1.65E+03	V	NA	NA	NA	NA	—	2.0E-07	—	8.7E-06	8.9E-06	<0.1%		
Methyl-t-Butyl Ether (MTBE)	6.74E-03		4.07E+03	V	3.1E-13	—	7.9E-13	1.1E-12	<0.1%	NA	NA	3.8E-09	3.8E-09	<0.1%		
n-Butylbenzene	1.32E+00		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
n-Propylbenzene	1.91E+00		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
o-Xylene	7.70E+00		5.16E+03	V	NA	NA	NA	NA	—	9.9E-07	—	3.9E-05	4.0E-05	<0.1%		
p/m-Xylene	1.50E+01		3.79E+03	V	NA	NA	NA	NA	—	1.9E-05	—	2.4E-04	2.6E-04	0.3%		
p-Isopropyltoluene	6.99E-02		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
sec-Butylbenzene	1.48E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
Tert-Butyl Alcohol (TBA)	4.30E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
tert-Butylbenzene	1.46E-01	m	7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—		
Toluene	3.46E+00		3.90E+03	V	NA	NA	NA	NA	—	1.1E-06	—	5.4E-05	5.5E-05	<0.1%		
Xylenes, total	2.26E+01		4.39E+03	V	NA	NA	NA	NA	—	2.9E-05	—	1.3E-04	1.6E-04	0.2%		
Semivolatile Organic Compounds (SVOCs)																
1-Methylnaphthalene	2.22E+01		1.63E+05	V	1.7E-08	—	NA	1.7E-08	0.7%	NA	NA	NA	NA	—		
2-Methylnaphthalene	3.72E+01		1.13E+05	V	NA	NA	NA	NA	—	2.4E-03	—	NA	2.4E-03	2.7%		
Acenaphthene	1.24E+00		2.12E+05	V	NA	NA	NA	NA	—	5.3E-07	1.1E-06	NA	1.6E-06	<0.1%		

Revised Table F-5
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index			
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi	HI	
Acenaphthylene	1.02E-01	1.63E+05	V	NA	NA	NA	–	NA	NA	NA	NA	
Anthracene	1.49E-01	7.70E+05	V	NA	NA	NA	–	1.3E-08	2.7E-08	NA	4.0E-08 <0.1%	
Benzo(a)anthracene	3.04E-01	1.00E+06	P	9.4E-09	2.0E-08	6.1E-11	2.9E-08	1.2%	NA	NA	NA	
Benzo(a)pyrene	1.44E-01	1.00E+06	P	4.5E-08	9.3E-08	2.9E-10	1.4E-07	5.8%	NA	NA	NA	
Benzo(b)fluoranthene	9.40E-02	1.00E+06	P	2.9E-09	6.0E-09	1.9E-11	9.0E-09	0.4%	NA	NA	NA	
Benzo(ghi)perylene	8.15E-02	1.00E+06	P	NA	NA	NA	–	NA	NA	NA	NA	
Benzo(k)fluoranthene	6.03E-02	1.00E+06	P	1.9E-09	3.9E-09	1.2E-11	5.8E-09	0.2%	NA	NA	NA	
Chrysene	6.53E-01	1.00E+06	P	2.0E-09	4.2E-09	1.3E-11	6.2E-09	0.3%	NA	NA	NA	
Dibenz(a,h)anthracene	6.70E-02	1.00E+06	P	7.1E-09	1.5E-08	1.5E-10	2.2E-08	0.9%	NA	NA	NA	
Fluoranthene	2.37E-01	1.00E+06	P	NA	NA	NA	–	1.5E-07	3.2E-07	NA	4.7E-07 <0.1%	
Fluorene	1.80E+00	5.02E+05	V	NA	NA	NA	–	1.2E-06	2.4E-06	NA	3.6E-06 <0.1%	
Indeno(1,2,3-cd)pyrene	5.03E-02	1.00E+06	P	1.6E-09	3.2E-09	1.0E-11	4.8E-09	0.2%	NA	NA	NA	
Naphthalene	5.06E+00	5.49E+04	V	NA	NA	5.7E-09	5.7E-09	0.2%	6.5E-06	1.4E-05	1.9E-04	
Phenanthrene	4.47E+00	9.92E+05	V	NA	NA	NA	–	NA	NA	NA	NA	
Pyrene	1.32E+00	1.00E+06	P	NA	NA	NA	–	1.1E-06	2.4E-06	NA	3.5E-06 <0.1%	
Polychlorinated Biphenyls (PCBs)												
PCB-1254	5.00E-02	m	1.00E+06	P	2.6E-09	5.4E-09	5.2E-11	8.0E-09	0.3%	2.6E-04	5.4E-04	
PCB-1260	4.00E-02	m	1.00E+06	P	2.1E-09	4.3E-09	4.2E-11	6.4E-09	0.3%	NA	NA	
Inorganic Compounds												
Antimony	2.29E+00	1.00E+06	P	NA	NA	NA	–	1.5E-03	–	NA	1.5E-03 1.7%	
Arsenic	4.75E+00	1.00E+06	P	1.2E-06	4.8E-07	2.9E-08	1.7E-06	70.2%	4.1E-03	1.7E-03	5.8E-03 1.2E-02 13.2%	
Barium	1.93E+02	1.00E+06	P	NA	NA	NA	–	2.5E-04	–	7.1E-04	9.6E-04 1.1%	
Beryllium	7.96E-01	1.00E+06	P	NA	NA	3.5E-09	3.5E-09	0.1%	4.1E-05	–	2.1E-03 2.1E-03 2.4%	
Cadmium	4.96E-01	1.00E+06	P	NA	NA	3.8E-09	3.8E-09	0.2%	1.3E-04	7.1E-05	4.5E-04 6.5E-04 0.7%	
Chromium	5.91E+01	1.00E+06	P	NA	NA	NA	–	1.0E-05	–	NA	1.0E-05 <0.1%	
Chromium, Hexavalent	7.28E-01	1.00E+06	P	NA	NA	2.0E-07	2.0E-07	8.4%	9.4E-06	–	6.6E-05 7.6E-05 <0.1%	
Cobalt	1.35E+01	1.00E+06	P	NA	NA	2.2E-07	2.2E-07	9.3%	1.2E-02	–	4.1E-02 5.3E-02 60.1%	
Copper	7.33E+01	1.00E+06	P	NA	NA	NA	–	4.7E-04	–	NA	4.7E-04 0.5%	
Lead	1.45E+02	1.00E+06	P	NA	NA	3.2E-09	3.2E-09	0.1%	NA	NA	NA –	
Mercury	1.78E-01	1.00E+06	P	NA	NA	NA	–	1.5E-04	–	1.1E-04	2.6E-04 0.3%	
Molybdenum	3.52E+00	1.00E+06	P	NA	NA	NA	–	1.8E-04	–	NA	1.8E-04 0.2%	
Nickel	2.14E+01	1.00E+06	P	NA	NA	1.0E-08	1.0E-08	0.4%	2.8E-04	–	7.8E-03 8.1E-03 9.2%	
Selenium	1.06E+00	1.00E+06	P	NA	NA	NA	–	5.5E-05	–	9.6E-07	5.6E-05 <0.1%	
Vanadium	4.92E+01	1.00E+06	P	NA	NA	NA	–	1.8E-03	–	NA	1.8E-03 2.1%	

Revised Table F-5
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent HI
			Route-Specific Risk	Oral	Dermal			Route-Specific Hazard Quotient	Calculated Hazard Index	Total Hazard Index	
	ELCRo	ELCRd	ELCRI	ELCR	HQo	HQd	HQi	HI			
Zinc	1.89E+02	1.00E+06 P	NA	NA	NA	NA	–	1.6E-04	–	NA	1.6E-04 0.2%
Total Risk or Hazard			Total ELCR			2E-06	100%	Total HI			0.09 100%
Total Risk or Hazard from Arsenic						2E-06					0.01
Total Risk or Hazard without Arsenic						7E-07					0.08

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 20 \times 7 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7) / ([\text{VF or PEF}] \times 2,555 \times \text{RfC})$$

Revised Table F-6
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe:	Future
Receptor Population:	Site Worker
Receptor Age:	Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,1,2-Tetrachloroethane	1.20E-02	m	1.38E+04	V	1.1E-09	—	4.1E-09	5.2E-09	<0.1%	2.9E-06	—	NA	2.9E-06	<0.1%
1,1,2-Trichloroethane	7.70E-03	m	6.36E+03	V	1.9E-10	—	1.6E-09	1.8E-09	<0.1%	1.9E-06	—	NA	1.9E-06	<0.1%
1,2,3-Trichlorobenzene	9.00E-03	m	1.93E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
1,2,4-Trichlorobenzene	4.63E-03	m	4.23E+04	V	5.8E-12	—	NA	5.8E-12	<0.1%	4.5E-07	—	6.2E-06	6.7E-06	<0.1%
1,2,4-Trimethylbenzene	1.54E+01		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	1.7E-02	1.7E-02	11.1%
1,2-Dichloropropane	2.10E-03	m	3.52E+03	V	2.6E-11	—	4.9E-10	5.1E-10	<0.1%	NA	NA	3.4E-05	3.4E-05	<0.1%
1,3,5-Trimethylbenzene	6.51E+00		1.15E+04	V	NA	NA	NA	NA	—	1.3E-04	—	2.2E-02	2.2E-02	13.8%
2-Chlorotoluene	2.80E-03	m	1.30E+04	V	NA	NA	NA	NA	—	1.4E-07	—	NA	1.4E-07	<0.1%
2-Hexanone	3.13E-03	m	1.53E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
4-Chlorotoluene	2.10E-03	m	7.18E+03	V	NA	NA	NA	NA	—	2.9E-08	—	NA	2.9E-08	<0.1%
4-Methyl-2-Pentanone	1.20E-02	m	1.14E+04	V	NA	NA	NA	NA	—	1.5E-07	—	8.0E-08	2.3E-07	<0.1%
Benzene	4.70E-01		2.68E+03	V	1.6E-08	—	4.1E-07	4.3E-07	1.7%	1.2E-04	—	6.7E-04	7.8E-04	0.5%
Carbon Disulfide	9.45E-03		1.17E+03	V	NA	NA	NA	NA	—	9.2E-08	—	2.3E-06	2.4E-06	<0.1%
Chloroethane	6.50E-03	m	8.86E+02	V	NA	NA	NA	NA	—	NA	NA	5.6E-08	5.6E-08	<0.1%
Chloromethane	2.13E-03	m	1.55E+03	V	9.7E-12	—	2.0E-10	2.1E-10	<0.1%	NA	NA	3.5E-06	3.5E-06	<0.1%
Ethylbenzene	3.32E+00		5.29E+03	V	1.3E-08	—	1.3E-07	1.4E-07	0.6%	3.2E-05	—	7.2E-05	1.0E-04	<0.1%
Iodomethane	1.38E-02	m	1.32E+09	P	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Isopropylbenzene	3.13E-01		1.65E+03	V	NA	NA	NA	NA	—	3.1E-06	—	1.1E-04	1.1E-04	<0.1%
Methyl-t-Butyl Ether (MTBE)	6.74E-03		4.07E+03	V	4.2E-12	—	3.5E-11	3.9E-11	<0.1%	NA	NA	4.7E-08	4.7E-08	<0.1%
n-Butylbenzene	1.32E+00		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
n-Propylbenzene	1.91E+00		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
o-Xylene	7.70E+00		5.16E+03	V	NA	NA	NA	NA	—	3.8E-06	—	4.9E-04	4.9E-04	0.3%
p/m-Xylene	1.50E+01		3.79E+03	V	NA	NA	NA	NA	—	7.3E-05	—	9.0E-03	9.1E-03	5.8%
p-Isopropyltoluene	6.99E-02		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
sec-Butylbenzene	1.48E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Tert-Butyl Alcohol (TBA)	4.30E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
tert-Butylbenzene	1.46E-01	m	7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA	—
Toluene	3.46E+00		3.90E+03	V	NA	NA	NA	NA	—	4.2E-05	—	6.8E-04	7.2E-04	0.5%
Xylenes, total	2.26E+01		4.39E+03	V	NA	NA	NA	NA	—	1.1E-04	—	1.7E-03	1.8E-03	1.1%
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.22E+01		1.63E+05	V	2.3E-07	—	NA	2.3E-07	0.9%	NA	NA	NA	NA	—
2-Methylnaphthalene	3.72E+01		1.13E+05	V	NA	NA	NA	NA	—	9.1E-03	—	NA	9.1E-03	5.8%
Acenaphthene	1.24E+00		2.12E+05	V	NA	NA	NA	NA	—	2.0E-05	3.5E-05	NA	5.5E-05	<0.1%

Revised Table F-6
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi	HI			
Acenaphthylene	1.02E-01	1.63E+05	V	NA	NA	NA	—	NA	NA	NA	NA			
Anthracene	1.49E-01	7.70E+05	V	NA	NA	NA	—	4.9E-07	8.3E-07	NA	1.3E-06 <0.1%			
Benzo(a)anthracene	3.04E-01	1.32E+09	P	1.3E-07	2.2E-07	2.1E-12	3.4E-07	1.4%	NA	NA	NA			
Benzo(a)pyrene	1.44E-01	1.32E+09	P	6.1E-07	1.0E-06	9.8E-12	1.6E-06	6.6%	NA	NA	NA			
Benzo(b)fluoranthene	9.40E-02	1.32E+09	P	3.9E-08	6.7E-08	6.4E-13	1.1E-07	0.4%	NA	NA	NA			
Benzo(ghi)perylene	8.15E-02	1.32E+09	P	NA	NA	NA	—	NA	NA	NA	NA			
Benzo(k)fluoranthene	6.03E-02	1.32E+09	P	2.5E-08	4.3E-08	4.1E-13	6.9E-08	0.3%	NA	NA	NA			
Chrysene	6.53E-01	1.32E+09	P	2.7E-08	4.7E-08	4.4E-13	7.4E-08	0.3%	NA	NA	NA			
Dibenz(a,h)anthracene	6.70E-02	1.32E+09	P	9.6E-08	1.6E-07	5.0E-12	2.6E-07	1.0%	NA	NA	NA			
Fluoranthene	2.37E-01	1.32E+09	P	NA	NA	NA	—	5.8E-06	9.9E-06	NA	1.6E-05 <0.1%			
Fluorene	1.80E+00	5.02E+05	V	NA	NA	NA	—	4.4E-05	7.5E-05	NA	1.2E-04 <0.1%			
Indeno(1,2,3-cd)pyrene	5.03E-02	1.32E+09	P	2.1E-08	3.6E-08	3.4E-13	5.7E-08	0.2%	NA	NA	NA			
Naphthalene	5.06E+00	5.49E+04	V	NA	NA	2.6E-07	2.6E-07	1.0%	2.5E-04	4.2E-04	2.3E-03			
Phenanthrene	4.47E+00	9.92E+05	V	NA	NA	NA	—	NA	NA	NA	NA			
Pyrene	1.32E+00	1.32E+09	P	NA	NA	NA	—	4.3E-05	7.4E-05	NA	1.2E-04 <0.1%			
Polychlorinated Biphenyls (PCBs)														
PCB-1254	5.00E-02	m	1.32E+09	P	3.5E-08	6.0E-08	1.8E-12	9.5E-08	0.4%	2.4E-03	4.2E-03			
PCB-1260	4.00E-02	m	1.32E+09	P	2.8E-08	4.8E-08	1.4E-12	7.6E-08	0.3%	NA	NA			
Inorganic Compounds														
Antimony	2.29E+00	1.32E+09	P	NA	NA	NA	—	5.6E-03	—	NA	5.6E-03 3.6%			
Arsenic	4.75E+00	1.32E+09	P	1.6E-05	5.4E-06	9.7E-10	2.1E-05	84.7%	1.5E-02	5.3E-03	5.5E-05 2.1E-02			
Barium	1.93E+02	1.32E+09	P	NA	NA	NA	—	9.5E-04	—	6.7E-05	1.0E-03 0.6%			
Beryllium	7.96E-01	1.32E+09	P	NA	NA	1.2E-10	1.2E-10	<0.1%	3.9E-04	—	2.0E-05 4.1E-04			
Cadmium	4.96E-01	1.32E+09	P	NA	NA	1.3E-10	1.3E-10	<0.1%	4.9E-04	2.2E-04	4.3E-06 7.1E-04			
Chromium	5.91E+01	1.32E+09	P	NA	NA	NA	—	3.9E-05	—	NA	3.9E-05 <0.1%			
Chromium, Hexavalent	7.28E-01	1.32E+09	P	NA	NA	6.7E-09	6.7E-09	<0.1%	2.4E-04	—	6.3E-07 2.4E-04			
Cobalt	1.35E+01	1.32E+09	P	NA	NA	7.5E-09	7.5E-09	<0.1%	4.4E-02	—	3.9E-04 4.4E-02			
Copper	7.33E+01	1.32E+09	P	NA	NA	NA	—	1.8E-03	—	NA	1.8E-03 1.1%			
Lead	1.45E+02	1.32E+09	P	NA	NA	1.1E-10	1.1E-10	<0.1%	NA	NA	NA			
Mercury	1.78E-01	1.32E+09	P	NA	NA	NA	—	5.8E-04	—	1.0E-06	5.8E-04 0.4%			
Molybdenum	3.52E+00	1.32E+09	P	NA	NA	NA	—	6.9E-04	—	NA	6.9E-04 0.4%			
Nickel	2.14E+01	1.32E+09	P	NA	NA	3.4E-10	3.4E-10	<0.1%	1.0E-03	—	7.4E-05 1.1E-03			
Selenium	1.06E+00	1.32E+09	P	NA	NA	NA	—	2.1E-04	—	9.1E-09	2.1E-04 0.1%			
Vanadium	4.92E+01	1.32E+09	P	NA	NA	NA	—	6.9E-03	—	NA	6.9E-03 4.4%			

Revised Table F-6
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 1

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi		
Zinc	1.89E+02	1.32E+09 P	NA	NA	NA	NA	–	6.1E-04	–	NA	6.1E-04 0.4%	
Total Risk or Hazard			Total ELCR			2E-05	100%	Total HI			0.2 100%	
Total Risk or Hazard from Arsenic						2E-05					0.02	
Total Risk or Hazard without Arsenic						4E-06					0.1	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSd} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSd} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F11
Risk and Hazard Index Calculations for Commercial/Industrial Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Volatile Organic Compounds (VOCs)												
1,2,4-Trimethylbenzene	2.49E+01	2.90E+04	V	NA	NA	NA	—	NA	NA	2.8E-02	2.8E-02 12.1%	
1,3,5-Trimethylbenzene	8.22E+00	1.15E+04	V	NA	NA	NA	—	1.6E-04	—	2.7E-02	2.7E-02 11.8%	
Benzene	1.17E+01	2.68E+03	V	4.1E-07	—	1.0E-05	1.1E-05	19.7%	2.9E-03	—	1.7E-02 1.9E-02 8.4%	
Carbon Disulfide	4.50E-02	m	1.17E+03	V	NA	NA	—	4.4E-07	—	1.1E-05	1.1E-05 <0.1%	
Chloroform	6.00E-02	m	2.61E+03	V	6.5E-10	—	9.9E-09	1.1E-08	<0.1%	5.9E-06	—	1.8E-05 2.3E-05 <0.1%
Ethylbenzene	5.41E+00	5.29E+03	V	2.1E-08	—	2.1E-07	2.3E-07	0.4%	5.3E-05	—	1.2E-04 1.7E-04 <0.1%	
Isopropylbenzene	9.13E-01	1.65E+03	V	NA	NA	NA	—	8.9E-06	—	3.2E-04	3.3E-04 0.1%	
Methylene Chloride	4.70E-01	m	2.45E+03	V	2.3E-09	—	1.6E-08	1.8E-08	<0.1%	7.7E-06	—	1.1E-04 1.2E-04 <0.1%
Methyl-t-Butyl Ether (MTBE)	2.60E-03	m	4.07E+03	V	1.6E-12	—	1.4E-11	1.5E-11	<0.1%	NA	NA	1.8E-08 1.8E-08 <0.1%
n-Butylbenzene	2.18E+00	7.83E+03	V	NA	NA	NA	—	NA	NA	NA	NA —	
n-Propylbenzene	3.51E+00	6.62E+03	V	NA	NA	NA	—	NA	NA	NA	NA —	
o-Xylene	1.82E+00	5.16E+03	V	NA	NA	NA	—	8.9E-07	—	1.1E-04	1.2E-04 <0.1%	
p/m-Xylene	1.27E+01	3.79E+03	V	NA	NA	NA	—	6.2E-05	—	7.6E-03	7.7E-03 3.3%	
p-Isopropyltoluene	4.79E-01	8.17E+03	V	NA	NA	NA	—	NA	NA	NA	NA —	
sec-Butylbenzene	6.56E-01	7.06E+03	V	NA	NA	NA	—	NA	NA	NA	NA —	
Tert-Butyl Alcohol (TBA)	8.90E-02	m	1.95E+04	V	NA	NA	—	NA	NA	NA	NA —	
Tetrachloroethene	7.50E-03	m	2.50E+03	V	1.4E-09	—	1.4E-09	2.9E-09	<0.1%	7.3E-07	—	2.0E-05 2.0E-05 <0.1%
Toluene	3.03E-03	3.90E+03	V	NA	NA	NA	—	3.7E-08	—	5.9E-07	6.3E-07 <0.1%	
Xylenes, total	1.44E+01	4.39E+03	V	NA	NA	NA	—	7.0E-05	—	1.1E-03	1.1E-03 0.5%	
Semivolatile Organic Compounds (SVOCs)												
1-Methylnaphthalene	2.74E+00	1.63E+05	V	2.8E-08	—	NA	2.8E-08	<0.1%	NA	NA	NA —	
2-Methylnaphthalene	4.13E+00	1.13E+05	V	NA	NA	NA	—	1.0E-03	—	NA	1.0E-03 0.4%	
Acenaphthene	3.48E-01	2.12E+05	V	NA	NA	NA	—	5.7E-06	9.7E-06	NA	1.5E-05 <0.1%	
Acenaphthylene	2.80E-01	m	1.63E+05	V	NA	NA	—	NA	NA	NA	NA —	
Anthracene	4.59E-01	7.70E+05	V	NA	NA	NA	—	1.5E-06	2.6E-06	NA	4.1E-06 <0.1%	
Benzo(a)anthracene	6.50E-01	1.32E+09	P	2.7E-07	4.7E-07	4.4E-12	7.4E-07	1.4%	NA	NA	NA —	
Benzo(a)pyrene	2.97E-01	1.32E+09	P	1.2E-06	2.1E-06	2.0E-11	3.4E-06	6.2%	NA	NA	NA —	
Benzo(b)fluoranthene	9.63E-02	1.32E+09	P	4.0E-08	6.9E-08	6.5E-13	1.1E-07	0.2%	NA	NA	NA —	
Benzo(ghi)perylene	1.90E-01	1.32E+09	P	NA	NA	NA	—	NA	NA	NA	NA —	
Benzo(k)fluoranthene	1.64E-01	1.32E+09	P	6.9E-08	1.2E-07	1.1E-12	1.9E-07	0.3%	NA	NA	NA —	
Chrysene	9.10E-01	1.32E+09	P	3.8E-08	6.5E-08	6.2E-13	1.0E-07	0.2%	NA	NA	NA —	
Dibenz(a,h)anthracene	2.40E-01	m	1.32E+09	P	3.4E-07	5.9E-07	1.8E-11	9.3E-07	1.7%	NA	NA —	
Fluoranthene	3.52E-01	1.32E+09	P	NA	NA	NA	—	8.6E-06	1.5E-05	NA	2.3E-05 <0.1%	

Revised Table F11
Risk and Hazard Index Calculations for Commercial/Industrial Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi		
Fluorene	5.94E-01	5.02E+05	V	NA	NA	NA	—	1.5E-05	2.5E-05	NA	3.9E-05 <0.1%	
Indeno(1,2,3-cd)pyrene	9.39E-02	1.32E+09	P	3.9E-08	6.7E-08	6.4E-13	1.1E-07 0.2%	NA	NA	NA	NA —	
Naphthalene	2.84E+00	5.49E+04	V	NA	NA	1.4E-07	1.4E-07 0.3%	1.4E-04	2.4E-04	1.3E-03	1.7E-03 0.7%	
Phenanthrene	3.63E+00	9.92E+05	V	NA	NA	NA	—	NA	NA	NA	NA —	
Pyrene	1.34E+00	1.32E+09	P	NA	NA	NA	—	4.4E-05	7.5E-05	NA	1.2E-04 <0.1%	
Pesticides and Herbicides												
Dieldrin	1.90E-02	m	1.32E+09	P	1.1E-07	6.1E-08	5.4E-12 0.3%	1.7E-07	3.7E-04	2.1E-04	NA 5.8E-04 0.3%	
Polychlorinated Biphenyls (PCBs)												
PCB-1254	8.50E-02	m	1.32E+09	P	5.9E-08	1.0E-07	3.0E-12 0.3%	1.6E-07	4.2E-03	7.1E-03	NA 1.1E-02 4.9%	
Inorganic Compounds												
Antimony	1.51E+00	1.32E+09	P	NA	NA	NA	—	3.7E-03	—	NA	3.7E-03 1.6%	
Arsenic	8.43E+00	1.32E+09	P	2.8E-05	9.5E-06	1.7E-09	3.7E-05 68.7%	2.7E-02	9.4E-03	9.7E-05	3.7E-02 16.0%	
Barium	2.03E+02	1.32E+09	P	NA	NA	NA	—	9.9E-04	—	7.0E-05	1.1E-03 0.5%	
Beryllium	8.32E-01	1.32E+09	P	NA	NA	1.2E-10	1.2E-10 <0.1%	4.1E-04	—	2.1E-05	4.3E-04 0.2%	
Cadmium	1.39E+00	1.32E+09	P	NA	NA	3.6E-10	3.6E-10 <0.1%	1.4E-03	6.2E-04	1.2E-05	2.0E-03 0.9%	
Chromium	6.47E+01	1.32E+09	P	NA	NA	NA	—	4.2E-05	—	NA	4.2E-05 <0.1%	
Cobalt	1.58E+01	1.32E+09	P	NA	NA	8.8E-09	8.8E-09 <0.1%	5.2E-02	—	4.6E-04	5.2E-02 22.5%	
Copper	3.43E+02	1.32E+09	P	NA	NA	NA	—	8.4E-03	—	NA	8.4E-03 3.6%	
Lead	1.37E+02	1.32E+09	P	NA	NA	1.0E-10	1.0E-10 <0.1%	NA	NA	NA	NA —	
Mercury	2.36E-01	1.32E+09	P	NA	NA	NA	—	7.7E-04	—	1.4E-06	7.7E-04 0.3%	
Molybdenum	7.84E+00	1.32E+09	P	NA	NA	NA	—	1.5E-03	—	NA	1.5E-03 0.7%	
Nickel	3.21E+02	1.32E+09	P	NA	NA	5.1E-09	5.1E-09 <0.1%	1.6E-02	—	1.1E-03	1.7E-02 7.2%	
Selenium	1.89E+00	1.32E+09	P	NA	NA	NA	—	3.7E-04	—	1.6E-08	3.7E-04 0.2%	
Silver	2.49E+00	m	1.32E+09	P	NA	NA	NA	—	4.9E-04	—	NA 4.9E-04 0.2%	
Vanadium	4.88E+01	1.32E+09	P	NA	NA	NA	—	6.8E-03	—	NA	6.8E-03 2.9%	
Zinc	3.12E+02	1.32E+09	P	NA	NA	NA	—	1.0E-03	—	NA	1.0E-03 0.4%	

Revised Table F11
Risk and Hazard Index Calculations for Commercial/Industrial Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: [Current/Future](#)
 Receptor Population: [Site Worker](#)
 Receptor Age: [Adult](#)

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi		
Total Risk or Hazard			Total ELCR			5E-05	100%	Total HI			0.2 100%	
Total Risk or Hazard from Arsenic						4E-05					0.04	
Total Risk or Hazard without Arsenic						2E-05					0.2	

Notes:

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F-14
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,2,4-Trimethylbenzene	2.03E+01	2.90E+04 V	NA	NA	NA	NA	—	NA	NA	2.3E-02	2.3E-02 0.9%			
1,2-Dichlorobenzene	1.29E-01 m	1.43E+04 V	NA	NA	NA	NA	—	4.6E-07	—	1.0E-06	1.5E-06 <0.1%			
1,2-Dichloropropane	1.90E-02 m	3.52E+03 V	3.2E-11	—	1.8E-10	2.1E-10	<0.1%	NA	NA	9.5E-05	9.5E-05 <0.1%			
1,3,5-Trimethylbenzene	2.81E+00	1.15E+04 V	NA	NA	NA	NA	—	1.8E-04	—	9.3E-03	9.5E-03 0.4%			
Benzene	4.04E+00	2.68E+03 V	1.9E-08	—	1.4E-07	1.6E-07	2.3%	1.1E-03	—	5.7E-03	6.8E-03 0.3%			
Carbon Disulfide	4.50E-02 m	1.17E+03 V	NA	NA	NA	NA	—	1.5E-06	—	1.1E-05	1.2E-05 <0.1%			
Chloroform	6.00E-02 m	2.61E+03 V	8.6E-11	—	4.0E-10	4.8E-10	<0.1%	1.9E-05	—	1.8E-05	3.7E-05 <0.1%			
Ethylbenzene	1.93E+00	5.29E+03 V	9.8E-10	—	3.0E-09	3.9E-09	<0.1%	6.2E-06	—	4.2E-05	4.8E-05 <0.1%			
Isopropylbenzene	3.24E-01	1.65E+03 V	NA	NA	NA	NA	—	2.6E-06	—	1.1E-04	1.1E-04 <0.1%			
Methylene Chloride	4.70E-01 m	2.45E+03 V	3.0E-10	—	6.3E-10	9.3E-10	<0.1%	2.5E-05	—	1.1E-04	1.3E-04 <0.1%			
Methyl-t-Butyl Ether (MTBE)	2.72E-03	4.07E+03 V	2.3E-13	—	5.7E-13	7.9E-13	<0.1%	NA	NA	1.9E-08	1.9E-08 <0.1%			
n-Butylbenzene	1.78E+00	7.83E+03 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
n-Propylbenzene	1.22E+00	6.62E+03 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
o-Xylene	6.15E-01	5.16E+03 V	NA	NA	NA	NA	—	9.9E-07	—	3.9E-05	4.0E-05 <0.1%			
p/m-Xylene	9.92E+00	3.79E+03 V	NA	NA	NA	NA	—	1.6E-04	—	2.0E-03	2.2E-03 <0.1%			
p-Isopropyltoluene	1.65E-01	8.17E+03 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
sec-Butylbenzene	2.36E-01	7.06E+03 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
Tert-Butyl Alcohol (TBA)	1.91E-02	1.95E+04 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
tert-Butylbenzene	1.10E-01 m	7.06E+03 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
Tetrachloroethene	7.50E-03 m	2.50E+03 V	1.9E-10	—	5.8E-11	2.4E-10	<0.1%	2.4E-07	—	2.0E-05	2.0E-05 <0.1%			
Toluene	9.43E-02	3.90E+03 V	NA	NA	NA	NA	—	3.8E-07	—	1.8E-05	1.9E-05 <0.1%			
Xylenes, total	1.13E+01	4.39E+03 V	NA	NA	NA	NA	—	1.8E-04	—	8.4E-04	1.0E-03 <0.1%			
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.19E+00	1.63E+05 V	2.9E-09	—	NA	2.9E-09	<0.1%	NA	NA	NA	NA —			
2-Methylnaphthalene	3.28E+00	1.13E+05 V	NA	NA	NA	NA	—	2.6E-03	—	NA	2.6E-03 <0.1%			
Acenaphthene	1.96E-01	2.12E+05 V	NA	NA	NA	NA	—	1.1E-06	2.2E-06	NA	3.2E-06 <0.1%			
Acenaphthylene	1.11E-02	1.63E+05 V	NA	NA	NA	NA	—	NA	NA	NA	NA —			
Anthracene	4.80E-01	7.70E+05 V	NA	NA	NA	NA	—	5.2E-07	1.1E-06	NA	1.6E-06 <0.1%			
Benzo(a)anthracene	4.77E-01	1.00E+06 P	2.6E-08	5.5E-08	1.7E-10	8.1E-08	1.2%	NA	NA	NA	NA —			
Benzo(a)pyrene	3.17E-01	1.00E+06 P	1.8E-07	3.6E-07	1.1E-09	5.4E-07	7.7%	NA	NA	NA	NA —			
Benzo(b)fluoranthene	1.81E-01	1.00E+06 P	1.0E-08	2.1E-08	6.5E-11	3.1E-08	0.4%	NA	NA	NA	NA —			
Benzo(ghi)perylene	1.04E-01	1.00E+06 P	NA	NA	NA	NA	—	NA	NA	NA	NA —			
Benzo(k)fluoranthene	2.74E-01	1.00E+06 P	1.5E-08	3.1E-08	9.8E-11	4.7E-08	0.7%	NA	NA	NA	NA —			

Revised Table F-14
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK				Percent Total ELCR	NON-CANCER HAZARD INDEX				Percent Total HI		
			Route-Specific Risk			Calculated Risk		Route-Specific Hazard Quotient						
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi				
Chrysene	6.62E-01	1.00E+06 P	3.7E-09	7.6E-09	2.4E-11	1.1E-08	0.2%	NA	NA	NA	NA	-		
Dibenz(a,h)anthracene	2.18E-02	1.00E+06 P	4.1E-09	8.5E-09	8.5E-11	1.3E-08	0.2%	NA	NA	NA	NA	-		
Fluoranthene	1.04E+00	1.00E+06 P	NA	NA	NA	NA	-	8.4E-06	1.7E-05	NA	2.6E-05	<0.1%		
Fluorene	2.34E-01	5.02E+05 V	NA	NA	NA	NA	-	1.9E-06	3.9E-06	NA	5.8E-06	<0.1%		
Indeno(1,2,3-cd)pyrene	7.86E-02	1.00E+06 P	4.4E-09	9.0E-09	2.8E-11	1.3E-08	0.2%	NA	NA	NA	NA	-		
Naphthalene	9.39E-01	5.49E+04 V	NA	NA	NA	1.9E-09	1.9E-09	<0.1%	1.5E-05	3.1E-05	4.3E-04	4.8E-04	<0.1%	
Phenanthrene	2.09E+00	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-		
Pyrene	1.41E+00	1.00E+06 P	NA	NA	NA	NA	-	1.5E-05	3.1E-05	NA	4.6E-05	<0.1%		
Pesticides and Herbicides														
Dieldrin	1.90E-02 m	1.00E+06 P	1.4E-08	9.7E-09	2.9E-10	2.4E-08	0.3%	1.2E-03	8.5E-04	NA	2.1E-03	<0.1%		
Polychlorinated Biphenyls (PCBs)														
PCB-1254	2.24E+00	1.00E+06 P	2.1E-07	4.3E-07	4.2E-09	6.4E-07	9.0%	1.4E-01	3.0E-01	NA	4.4E-01	16.6%		
PCB-1260	7.50E-02 m	1.00E+06 P	6.9E-09	1.4E-08	1.4E-10	2.1E-08	0.3%	NA	NA	NA	NA	-		
Inorganic Compounds														
Antimony	2.27E+00	1.00E+06 P	NA	NA	NA	NA	-	1.8E-02	-	NA	1.8E-02	0.7%		
Arsenic	7.38E+00	1.00E+06 P	3.2E-06	1.3E-06	7.9E-08	4.6E-06	65.6%	7.9E-02	3.3E-02	1.1E-01	2.2E-01	8.4%		
Barium	2.01E+02	1.00E+06 P	NA	NA	NA	NA	-	3.2E-03	-	9.2E-03	1.2E-02	0.5%		
Beryllium	9.64E-01	1.00E+06 P	NA	NA	7.5E-09	7.5E-09	0.1%	6.2E-04	-	3.1E-02	3.2E-02	1.2%		
Cadmium	7.03E-01	1.00E+06 P	NA	NA	9.6E-09	9.6E-09	0.1%	2.3E-03	1.3E-03	8.0E-03	1.2E-02	0.4%		
Chromium	5.63E+01	1.00E+06 P	NA	NA	NA	NA	-	1.2E-04	-	NA	1.2E-04	<0.1%		
Chromium, Hexavalent	2.95E-01 m	1.00E+06 P	NA	NA	1.4E-07	1.4E-07	2.0%	4.8E-05	-	3.4E-04	3.8E-04	<0.1%		
Cobalt	1.65E+01	1.00E+06 P	NA	NA	4.8E-07	4.8E-07	6.9%	1.8E-01	-	6.3E-01	8.0E-01	30.2%		
Copper	1.45E+02	1.00E+06 P	NA	NA	NA	NA	-	1.2E-02	-	NA	1.2E-02	0.4%		
Lead	9.38E+01	1.00E+06 P	NA	NA	3.7E-09	3.7E-09	<0.1%	NA	NA	NA	NA	-		
Mercury	1.67E-01	1.00E+06 P	NA	NA	NA	NA	-	1.8E-03	-	1.3E-03	3.1E-03	0.1%		
Molybdenum	5.83E+00	1.00E+06 P	NA	NA	NA	NA	-	3.8E-03	-	NA	3.8E-03	0.1%		
Nickel	2.16E+02	1.00E+06 P	NA	NA	1.8E-07	1.8E-07	2.6%	3.5E-02	-	9.9E-01	1.0E+00	38.3%		
Selenium	1.61E+00	1.00E+06 P	NA	NA	NA	NA	-	1.0E-03	-	1.8E-05	1.1E-03	<0.1%		
Silver	2.49E+00 m	1.00E+06 P	NA	NA	NA	NA	-	1.6E-03	-	NA	1.6E-03	<0.1%		
Vanadium	5.66E+01	1.00E+06 P	NA	NA	NA	NA	-	2.6E-02	-	NA	2.6E-02	1.0%		
Zinc	2.31E+02	1.00E+06 P	NA	NA	NA	NA	-	2.5E-03	-	NA	2.5E-03	<0.1%		

Revised Table F-14
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Percent ELCR	NON-CANCER HAZARD INDEX			Percent HI
			Route-Specific Risk				Route-Specific Hazard Quotient	Calculated Hazard Index		
			Oral	Dermal	Inhalation		Oral	Dermal	Inhalation	
			ELCRo	ELCRd	ELCRi	ELCR	HQo	HQd	HQi	HI
Total Risk or Hazard			Total ELCR		7E-06	100%	Total HI **		3	100%
Total Risk or Hazard from Arsenic					5E-06				0.2	
Total Risk or Hazard without Arsenic					2E-06				2	

** HI Segregated by Target Site/Critical Effect:

HI (liver, kidney) =	0.05	HI (forestomach, gastrointestinal tract) =	0.004
HI (CNS, whole body, immune system) =	0.1	HI (nasal, lung) =	0.6
HI (blood) =	0.2	HI (eyes, nails, hair, skin) =	0.03
HI (fetus, developmental) =	0.00002	HI (NA, NR) =	1

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

- = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1) / ([\text{VF or PEF}] \times 365 \times \text{RfC})$$

Revised Table F-15
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Trench/Utility Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard INDEX					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,2,4-Trimethylbenzene	2.03E+01	2.90E+04 V	NA	NA	NA	NA	–	NA	NA	1.8E-03	1.8E-03 0.9%			
1,2-Dichlorobenzene	1.29E-01 m	1.43E+04 V	NA	NA	NA	NA	–	3.7E-08	–	8.2E-08	1.2E-07 <0.1%			
1,2-Dichloropropane	1.90E-02 m	3.52E+03 V	1.8E-11	–	9.9E-11	1.2E-10	<0.1%	NA	NA	7.6E-06	7.6E-06 <0.1%			
1,3,5-Trimethylbenzene	2.81E+00	1.15E+04 V	NA	NA	NA	NA	–	1.5E-05	–	7.4E-04	7.6E-04 0.4%			
Benzene	4.04E+00	2.68E+03 V	1.0E-08	–	8.0E-08	9.0E-08	2.3%	8.7E-05	–	4.6E-04	5.5E-04 0.3%			
Carbon Disulfide	4.50E-02 m	1.17E+03 V	NA	NA	NA	NA	–	1.2E-07	–	8.8E-07	1.0E-06 <0.1%			
Chloroform	6.00E-02 m	2.61E+03 V	4.8E-11	–	2.2E-10	2.7E-10	<0.1%	1.5E-06	–	1.4E-06	3.0E-06 <0.1%			
Ethylbenzene	1.93E+00	5.29E+03 V	5.5E-10	–	1.7E-09	2.2E-09	<0.1%	5.0E-07	–	3.3E-06	3.8E-06 <0.1%			
Isopropylbenzene	3.24E-01	1.65E+03 V	NA	NA	NA	NA	–	2.1E-07	–	9.0E-06	9.2E-06 <0.1%			
Methylene Chloride	4.70E-01 m	2.45E+03 V	1.7E-10	–	3.5E-10	5.2E-10	<0.1%	2.0E-06	–	8.8E-06	1.1E-05 <0.1%			
Methyl-t-Butyl Ether (MTBE)	2.72E-03	4.07E+03 V	1.3E-13	–	3.2E-13	4.4E-13	<0.1%	NA	NA	1.5E-09	1.5E-09 <0.1%			
n-Butylbenzene	1.78E+00	7.83E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
n-Propylbenzene	1.22E+00	6.62E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
o-Xylene	6.15E-01	5.16E+03 V	NA	NA	NA	NA	–	7.9E-08	–	3.1E-06	3.2E-06 <0.1%			
p/m-Xylene	9.92E+00	3.79E+03 V	NA	NA	NA	NA	–	1.3E-05	–	1.6E-04	1.7E-04 <0.1%			
p-Isopropyltoluene	1.65E-01	8.17E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
sec-Butylbenzene	2.36E-01	7.06E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Tert-Butyl Alcohol (TBA)	1.91E-02	1.95E+04 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
tert-Butylbenzene	1.10E-01 m	7.06E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Tetrachloroethene	7.50E-03 m	2.50E+03 V	1.0E-10	–	3.2E-11	1.4E-10	<0.1%	1.9E-08	–	1.6E-06	1.6E-06 <0.1%			
Toluene	9.43E-02	3.90E+03 V	NA	NA	NA	NA	–	3.0E-08	–	1.5E-06	1.5E-06 <0.1%			
Xylenes, total	1.13E+01	4.39E+03 V	NA	NA	NA	NA	–	1.5E-05	–	6.7E-05	8.2E-05 <0.1%			
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.19E+00	1.63E+05 V	1.6E-09	–	NA	1.6E-09	<0.1%	NA	NA	NA	NA –			
2-Methylnaphthalene	3.28E+00	1.13E+05 V	NA	NA	NA	NA	–	2.1E-04	–	NA	2.1E-04 <0.1%			
Acenaphthene	1.96E-01	2.12E+05 V	NA	NA	NA	NA	–	8.4E-08	1.7E-07	NA	2.6E-07 <0.1%			
Acenaphthylene	1.11E-02	1.63E+05 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Anthracene	4.80E-01	7.70E+05 V	NA	NA	NA	NA	–	4.1E-08	8.6E-08	NA	1.3E-07 <0.1%			
Benzo(a)anthracene	4.77E-01	1.00E+06 P	1.5E-08	3.1E-08	9.6E-11	4.5E-08	1.2%	NA	NA	NA	NA –			
Benzo(a)pyrene	3.17E-01	1.00E+06 P	9.8E-08	2.0E-07	6.4E-10	3.0E-07	7.7%	NA	NA	NA	NA –			
Benzo(b)fluoranthene	1.81E-01	1.00E+06 P	5.6E-09	1.2E-08	3.6E-11	1.7E-08	0.4%	NA	NA	NA	NA –			
Benzo(ghi)perylene	1.04E-01	1.00E+06 P	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Benzo(k)fluoranthene	2.74E-01	1.00E+06 P	8.5E-09	1.8E-08	5.5E-11	2.6E-08	0.7%	NA	NA	NA	NA –			

Revised Table F-15
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Trench/Utility Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard INDEX					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Chrysene	6.62E-01	1.00E+06 P	2.1E-09	4.3E-09	1.3E-11	6.3E-09	0.2%	NA	NA	NA	NA -			
Dibenzo(a,h)anthracene	2.18E-02	1.00E+06 P	2.3E-09	4.8E-09	4.8E-11	7.1E-09	0.2%	NA	NA	NA	NA -			
Fluoranthene	1.04E+00	1.00E+06 P	NA	NA	NA	NA	-	6.7E-07	1.4E-06	NA	2.1E-06 <0.1%			
Fluorene	2.34E-01	5.02E+05 V	NA	NA	NA	NA	-	1.5E-07	3.1E-07	NA	4.6E-07 <0.1%			
Indeno(1,2,3-cd)pyrene	7.86E-02	1.00E+06 P	2.4E-09	5.1E-09	1.6E-11	7.5E-09	0.2%	NA	NA	NA	NA -			
Naphthalene	9.39E-01	5.49E+04 V	NA	NA	1.1E-09	1.1E-09	<0.1%	1.2E-06	2.5E-06	3.5E-05	3.8E-05 <0.1%			
Phenanthrene	2.09E+00	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA -			
Pyrene	1.41E+00	1.00E+06 P	NA	NA	NA	NA	-	1.2E-06	2.5E-06	NA	3.7E-06 <0.1%			
Pesticides and Herbicides														
Dieldrin	1.90E-02 m	1.00E+06 P	7.9E-09	1.1E-08	1.6E-10	1.9E-08	0.5%	9.8E-05	1.4E-04	NA	2.3E-04 0.1%			
Polychlorinated Biphenyls (PCBs)														
PCB-1254	2.24E+00	1.00E+06 P	1.2E-07	2.4E-07	2.3E-09	3.6E-07	9.0%	1.2E-02	2.4E-02	NA	3.5E-02 16.6%			
PCB-1260	7.50E-02 m	1.00E+06 P	3.9E-09	8.0E-09	7.8E-11	1.2E-08	0.3%	NA	NA	NA	NA -			
Inorganic Compounds														
Antimony	2.27E+00	1.00E+06 P	NA	NA	NA	NA	-	1.5E-03	-	NA	1.5E-03 0.7%			
Arsenic	7.38E+00	1.00E+06 P	1.8E-06	7.5E-07	4.4E-08	2.6E-06	65.5%	6.4E-03	2.6E-03	9.0E-03	1.8E-02 8.4%			
Barium	2.01E+02	1.00E+06 P	NA	NA	NA	NA	-	2.6E-04	-	7.3E-04	9.9E-04 0.5%			
Beryllium	9.64E-01	1.00E+06 P	NA	NA	4.2E-09	4.2E-09	0.1%	5.0E-05	-	2.5E-03	2.6E-03 1.2%			
Cadmium	7.03E-01	1.00E+06 P	NA	NA	5.4E-09	5.4E-09	0.1%	1.8E-04	1.0E-04	6.4E-04	9.2E-04 0.4%			
Chromium	5.63E+01	1.00E+06 P	NA	NA	NA	NA	-	9.7E-06	-	NA	9.7E-06 <0.1%			
Chromium, Hexavalent	2.95E-01 m	1.00E+06 P	NA	NA	8.1E-08	8.1E-08	2.0%	3.8E-06	-	2.7E-05	3.1E-05 <0.1%			
Cobalt	1.65E+01	1.00E+06 P	NA	NA	2.7E-07	2.7E-07	6.8%	1.4E-02	-	5.0E-02	6.4E-02 30.2%			
Copper	1.45E+02	1.00E+06 P	NA	NA	NA	NA	-	9.4E-04	-	NA	9.4E-04 0.4%			
Lead	9.38E+01	1.00E+06 P	NA	NA	2.1E-09	2.1E-09	<0.1%	NA	NA	NA	NA -			
Mercury	1.67E-01	1.00E+06 P	NA	NA	NA	NA	-	1.4E-04	-	1.0E-04	2.5E-04 0.1%			
Molybdenum	5.83E+00	1.00E+06 P	NA	NA	NA	NA	-	3.0E-04	-	NA	3.0E-04 0.1%			
Nickel	2.16E+02	1.00E+06 P	NA	NA	1.0E-07	1.0E-07	2.6%	2.8E-03	-	7.9E-02	8.2E-02 38.3%			
Selenium	1.61E+00	1.00E+06 P	NA	NA	NA	NA	-	8.3E-05	-	1.5E-06	8.4E-05 <0.1%			
Silver	2.49E+00 m	1.00E+06 P	NA	NA	NA	NA	-	1.3E-04	-	NA	1.3E-04 <0.1%			
Vanadium	5.66E+01	1.00E+06 P	NA	NA	NA	NA	-	2.1E-03	-	NA	2.1E-03 1.0%			
Zinc	2.31E+02	1.00E+06 P	NA	NA	NA	NA	-	2.0E-04	-	NA	2.0E-04 <0.1%			

Revised Table F-15
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Trench/Utility Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Total Risk or Hazard			Total ELCR			4E-06	100%	Total HI			0.2 100%	
Total Risk or Hazard from Arsenic						3E-06					0.02	
Total Risk or Hazard without Arsenic						1E-06					0.2	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 20 \times 7 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7) / ([\text{VF or PEF}] \times 2,555 \times \text{RFC})$$

Revised Table F-16
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Volatile Organic Compounds (VOCs)												
1,2,4-Trimethylbenzene	2.03E+01	2.90E+04	V	NA	NA	NA	–	NA	NA	2.3E-02	2.3E-02 4.9%	
1,2-Dichlorobenzene	1.29E-01	m	1.43E+04	V	NA	NA	–	1.4E-06	–	1.0E-05	1.2E-05 <0.1%	
1,2-Dichloropropane	1.90E-02	m	3.52E+03	V	2.4E-10	–	4.4E-09	4.6E-09 <0.1%	NA	NA	3.1E-04 3.1E-04 <0.1%	
1,3,5-Trimethylbenzene	2.81E+00		1.15E+04	V	NA	NA	–	5.5E-05	–	9.3E-03	9.3E-03 2.0%	
Benzene	4.04E+00		2.68E+03	V	1.4E-07	–	3.6E-06	3.7E-06 8.0%	9.9E-04	–	5.7E-03 6.7E-03 1.4%	
Carbon Disulfide	4.50E-02	m	1.17E+03	V	NA	NA	–	4.4E-07	–	1.1E-05	1.1E-05 <0.1%	
Chloroform	6.00E-02	m	2.61E+03	V	6.5E-10	–	9.9E-09	1.1E-08 <0.1%	5.9E-06	–	1.8E-05 2.3E-05 <0.1%	
Ethylbenzene	1.93E+00		5.29E+03	V	7.4E-09	–	7.4E-08	8.2E-08 0.2%	1.9E-05	–	4.2E-05 6.0E-05 <0.1%	
Isopropylbenzene	3.24E-01		1.65E+03	V	NA	NA	NA	–	3.2E-06	–	1.1E-04 1.2E-04 <0.1%	
Methylene Chloride	4.70E-01	m	2.45E+03	V	2.3E-09	–	1.6E-08	1.8E-08 <0.1%	7.7E-06	–	1.1E-04 1.2E-04 <0.1%	
Methyl-t-Butyl Ether (MTBE)	2.72E-03		4.07E+03	V	1.7E-12	–	1.4E-11	1.6E-11 <0.1%	NA	NA	1.9E-08 1.9E-08 <0.1%	
n-Butylbenzene	1.78E+00		7.83E+03	V	NA	NA	NA	–	NA	NA	NA –	
n-Propylbenzene	1.22E+00		6.62E+03	V	NA	NA	NA	–	NA	NA	NA –	
o-Xylene	6.15E-01		5.16E+03	V	NA	NA	NA	–	3.0E-07	–	3.9E-05 3.9E-05 <0.1%	
p/m-Xylene	9.92E+00		3.79E+03	V	NA	NA	NA	–	4.9E-05	–	6.0E-03 6.0E-03 1.3%	
p-Isopropyltoluene	1.65E-01		8.17E+03	V	NA	NA	NA	–	NA	NA	NA –	
sec-Butylbenzene	2.36E-01		7.06E+03	V	NA	NA	NA	–	NA	NA	NA –	
Tert-Butyl Alcohol (TBA)	1.91E-02		1.95E+04	V	NA	NA	NA	–	NA	NA	NA –	
tert-Butylbenzene	1.10E-01	m	7.06E+03	V	NA	NA	NA	–	NA	NA	NA –	
Tetrachloroethene	7.50E-03	m	2.50E+03	V	1.4E-09	–	1.4E-09	2.9E-09 <0.1%	7.3E-07	–	2.0E-05 2.0E-05 <0.1%	
Toluene	9.43E-02		3.90E+03	V	NA	NA	NA	–	1.2E-06	–	1.8E-05 2.0E-05 <0.1%	
Xylenes, total	1.13E+01		4.39E+03	V	NA	NA	NA	–	5.5E-05	–	8.4E-04 8.9E-04 0.2%	
Semivolatile Organic Compounds (SVOCs)												
1-Methylnaphthalene	2.19E+00		1.63E+05	V	2.2E-08	–	NA	2.2E-08 <0.1%	NA	NA	NA –	
2-Methylnaphthalene	3.28E+00		1.13E+05	V	NA	NA	NA	–	8.0E-04	–	NA 8.0E-04 0.2%	
Acenaphthene	1.96E-01		2.12E+05	V	NA	NA	NA	–	3.2E-06	5.5E-06	NA 8.7E-06 <0.1%	
Acenaphthylene	1.11E-02		1.63E+05	V	NA	NA	NA	–	NA	NA	NA –	
Anthracene	4.80E-01		7.70E+05	V	NA	NA	NA	–	1.6E-06	2.7E-06	NA 4.2E-06 <0.1%	
Benzo(a)anthracene	4.77E-01		1.32E+09	P	2.0E-07	3.4E-07	3.2E-12	5.4E-07 1.2%	NA	NA	NA –	
Benzo(a)pyrene	3.17E-01		1.32E+09	P	1.3E-06	2.3E-06	2.2E-11	3.6E-06 7.8%	NA	NA	NA –	
Benzo(b)fluoranthene	1.81E-01		1.32E+09	P	7.6E-08	1.3E-07	1.2E-12	2.1E-07 0.4%	NA	NA	NA –	
Benzo(ghi)perylene	1.04E-01		1.32E+09	P	NA	NA	NA	–	NA	NA	NA –	
Benzo(k)fluoranthene	2.74E-01		1.32E+09	P	1.2E-07	2.0E-07	1.9E-12	3.1E-07 0.7%	NA	NA	NA –	

Revised Table F-16
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Chrysene	6.62E-01	1.32E+09 P	2.8E-08	4.7E-08	4.5E-13	7.5E-08	0.2%	NA	NA	NA	NA –	
Dibenzo(a,h)anthracene	2.18E-02	1.32E+09 P	3.1E-08	5.3E-08	1.6E-12	8.5E-08	0.2%	NA	NA	NA	NA –	
Fluoranthene	1.04E+00	1.32E+09 P	NA	NA	NA	NA	–	2.5E-05	4.3E-05	NA	6.9E-05 <0.1%	
Fluorene	2.34E-01	5.02E+05 V	NA	NA	NA	NA	–	5.7E-06	9.8E-06	NA	1.6E-05 <0.1%	
Indeno(1,2,3-cd)pyrene	7.86E-02	1.32E+09 P	3.3E-08	5.6E-08	5.3E-13	8.9E-08	0.2%	NA	NA	NA	NA –	
Naphthalene	9.39E-01	5.49E+04 V	NA	NA	4.7E-08	4.7E-08	0.1%	4.6E-05	7.9E-05	4.3E-04	5.6E-04 0.1%	
Phenanthrene	2.09E+00	9.92E+05 V	NA	NA	NA	NA	–	NA	NA	NA	NA –	
Pyrene	1.41E+00	1.32E+09 P	NA	NA	NA	NA	–	4.6E-05	7.8E-05	NA	1.2E-04 <0.1%	
Pesticides and Herbicides												
Dieldrin	1.90E-02	m	1.32E+09 P	1.1E-07	6.1E-08	5.4E-12	1.7E-07	0.4%	3.7E-04	2.1E-04	NA 5.8E-04 0.1%	
Polychlorinated Biphenyls (PCBs)												
PCB-1254	2.24E+00	1.32E+09 P	1.6E-06	2.7E-06	7.9E-11	4.2E-06	9.2%	1.1E-01	1.9E-01	NA	3.0E-01 63.6%	
PCB-1260	7.50E-02	m	1.32E+09 P	5.2E-08	9.0E-08	2.6E-12	1.4E-07	0.3%	NA	NA	NA –	
Inorganic Compounds												
Antimony	2.27E+00	1.32E+09 P	NA	NA	NA	NA	–	5.5E-03	–	NA	5.5E-03 1.2%	
Arsenic	7.38E+00	1.32E+09 P	2.4E-05	8.3E-06	1.5E-09	3.3E-05	71.0%	2.4E-02	8.2E-03	8.5E-05	3.2E-02 6.9%	
Barium	2.01E+02	1.32E+09 P	NA	NA	NA	NA	–	9.8E-04	–	7.0E-05	1.1E-03 0.2%	
Beryllium	9.64E-01	1.32E+09 P	NA	NA	1.4E-10	1.4E-10	<0.1%	4.7E-04	–	2.4E-05	5.0E-04 0.1%	
Cadmium	7.03E-01	1.32E+09 P	NA	NA	1.8E-10	1.8E-10	<0.1%	6.9E-04	3.1E-04	6.1E-06	1.0E-03 0.2%	
Chromium	5.63E+01	1.32E+09 P	NA	NA	NA	NA	–	3.7E-05	–	NA	3.7E-05 <0.1%	
Chromium, Hexavalent	2.95E-01	m	1.32E+09 P	NA	NA	2.7E-09	2.7E-09	<0.1%	9.6E-05	–	2.6E-07 9.6E-05 <0.1%	
Cobalt	1.65E+01	1.32E+09 P	NA	NA	9.2E-09	9.2E-09	<0.1%	5.4E-02	–	4.8E-04	5.4E-02 11.6%	
Copper	1.45E+02	1.32E+09 P	NA	NA	NA	NA	–	3.6E-03	–	NA	3.6E-03 0.8%	
Lead	9.38E+01	1.32E+09 P	NA	NA	7.0E-11	7.0E-11	<0.1%	NA	NA	NA	NA –	
Mercury	1.67E-01	1.32E+09 P	NA	NA	NA	NA	–	5.4E-04	–	9.6E-07	5.5E-04 0.1%	
Molybdenum	5.83E+00	1.32E+09 P	NA	NA	NA	NA	–	1.1E-03	–	NA	1.1E-03 0.2%	
Nickel	2.16E+02	1.32E+09 P	NA	NA	3.5E-09	3.5E-09	<0.1%	1.1E-02	–	7.5E-04	1.1E-02 2.4%	
Selenium	1.61E+00	1.32E+09 P	NA	NA	NA	NA	–	3.1E-04	–	1.4E-08	3.1E-04 <0.1%	
Silver	2.49E+00	m	1.32E+09 P	NA	NA	NA	–	4.9E-04	–	NA	4.9E-04 0.1%	
Vanadium	5.66E+01	1.32E+09 P	NA	NA	NA	NA	–	7.9E-03	–	NA	7.9E-03 1.7%	
Zinc	2.31E+02	1.32E+09 P	NA	NA	NA	NA	–	7.5E-04	–	NA	7.5E-04 0.2%	

Revised Table F-16
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 2

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index				
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation			
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		HI	
Total Risk or Hazard			Total ELCR			5E-05	100%	Total HI			0.5	100%	
Total Risk or Hazard from Arsenic						3E-05					0.03		
Total Risk or Hazard without Arsenic						1E-05					0.4		

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F-24
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Construction Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated				
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation			
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		HI	
Volatile Organic Compounds (VOCs)													
1,1,1-Trichloroethane	3.80E-03	m	2.17E+03	V	NA	NA	NA	NA	—	6.1E-09	—	4.0E-07	4.1E-07 <0.1%
1,1,2-Trichloroethane	2.60E-03	m	6.36E+03	V	8.6E-12	—	2.1E-11	3.0E-11	<0.1%	2.1E-07	—	NA	2.1E-07 <0.1%
1,2,3-Trichloropropane	5.50E-01	m	1.14E+04	V	1.8E-07	—	NA	1.8E-07	2.9%	3.0E-05	—	NA	3.0E-05 <0.1%
1,2,4-Trichlorobenzene	1.70E-01	m	4.23E+04	V	2.8E-11	—	NA	2.8E-11	<0.1%	5.5E-05	—	4.6E-07	5.5E-05 <0.1%
1,2,4-Trimethylbenzene	1.05E+01		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	1.2E-02	1.2E-02 0.7%
1,2-Dichlorobenzene	2.90E+00	m	1.43E+04	V	NA	NA	NA	NA	—	1.0E-05	—	2.3E-05	3.4E-05 <0.1%
1,2-Dichloropropane	2.20E-02	m	3.52E+03	V	3.7E-11	—	2.0E-10	2.4E-10	<0.1%	NA	NA	1.1E-04	1.1E-04 <0.1%
1,3,5-Trimethylbenzene	1.60E+00		1.15E+04	V	NA	NA	NA	NA	—	1.0E-04	—	5.3E-03	5.4E-03 0.3%
1,4-Dichlorobenzene	4.00E-01	m	1.28E+04	V	1.0E-10	—	1.1E-09	1.2E-09	<0.1%	NA	NA	9.0E-06	9.0E-06 <0.1%
Benzene	6.62E-01		2.68E+03	V	3.1E-09	—	2.3E-08	2.6E-08	0.4%	1.8E-04	—	9.4E-04	1.1E-03 <0.1%
Bromodichloromethane	1.40E-01	m	8.10E+03	V	8.4E-10	—	2.1E-09	2.9E-09	<0.1%	2.3E-05	—	NA	2.3E-05 <0.1%
c-1,2-Dichloroethene	1.75E-02	m	2.85E+03	V	NA	NA	NA	NA	—	5.7E-07	—	NA	5.7E-07 <0.1%
Carbon Disulfide	3.26E-03		1.17E+03	V	NA	NA	NA	NA	—	1.1E-07	—	8.0E-07	9.0E-07 <0.1%
Chloroform	5.91E-03		2.61E+03	V	8.5E-12	—	3.9E-11	4.8E-11	<0.1%	1.9E-06	—	1.7E-06	3.6E-06 <0.1%
Ethylbenzene	2.52E+00		5.29E+03	V	1.3E-09	—	3.9E-09	5.2E-09	<0.1%	8.1E-06	—	5.4E-05	6.2E-05 <0.1%
Iodomethane	5.00E-03	m	1.00E+06	P	NA	NA	NA	NA	—	NA	NA	NA	—
Isopropylbenzene	9.90E-01		1.65E+03	V	NA	NA	NA	NA	—	8.0E-06	—	3.4E-04	3.5E-04 <0.1%
Methylene Chloride	5.80E-01	m	2.45E+03	V	3.7E-10	—	7.7E-10	1.1E-09	<0.1%	3.1E-05	—	1.4E-04	1.7E-04 <0.1%
Methyl-t-Butyl Ether (MTBE)	5.15E-03		4.07E+03	V	4.3E-13	—	1.1E-12	1.5E-12	<0.1%	NA	NA	3.6E-08	3.6E-08 <0.1%
n-Butylbenzene	4.53E-01		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	—
n-Propylbenzene	1.75E+00		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	—
o-Xylene	3.48E+00		5.16E+03	V	NA	NA	NA	NA	—	5.6E-06	—	2.2E-04	2.3E-04 <0.1%
p/m-Xylene	7.96E+00		3.79E+03	V	NA	NA	NA	NA	—	1.3E-04	—	1.6E-03	1.7E-03 0.1%
p-Isopropyltoluene	4.15E-01		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	—
sec-Butylbenzene	5.65E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	—
t-1,2-Dichloroethene	2.00E-03	m	2.28E+03	V	NA	NA	NA	NA	—	3.2E-08	—	3.3E-06	3.4E-06 <0.1%
Tert-Butyl Alcohol (TBA)	4.14E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	—
tert-Butylbenzene	1.22E-02		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	—
Tetrachloroethene	1.53E-01	m	2.50E+03	V	3.8E-09	—	1.2E-09	5.0E-09	<0.1%	4.9E-06	—	4.0E-04	4.0E-04 <0.1%
Toluene	8.93E-01		3.90E+03	V	NA	NA	NA	NA	—	3.6E-06	—	1.7E-04	1.8E-04 <0.1%
Trichloroethene	5.63E-02	m	3.20E+03	V	3.4E-11	—	1.1E-10	1.5E-10	<0.1%	NA	NA	6.7E-06	6.7E-06 <0.1%
Vinyl Chloride	1.50E-03	m	1.02E+03	V	1.9E-11	—	3.7E-10	3.9E-10	<0.1%	1.6E-06	—	3.4E-06	5.0E-06 <0.1%
Xylenes, total	1.14E+01		4.39E+03	V	NA	NA	NA	NA	—	1.8E-04	—	8.4E-04	1.0E-03 <0.1%
Semivolatile Organic Compounds (SVOCs)													
1-Methylnaphthalene	1.92E+01		1.63E+05	V	2.6E-08	—	NA	2.6E-08	0.4%	NA	NA	NA	—
2-Methylnaphthalene	2.70E+01		1.13E+05	V	NA	NA	NA	NA	—	2.2E-02	—	NA	2.2E-02 1.4%
Acenaphthene	5.01E-01		2.12E+05	V	NA	NA	NA	NA	—	2.7E-06	5.6E-06	NA	8.3E-06 <0.1%
Acenaphthylene	1.50E-01		1.63E+05	V	NA	NA	NA	NA	—	NA	NA	NA	—
Anthracene	1.75E-01		7.70E+05	V	NA	NA	NA	NA	—	1.9E-07	3.9E-07	NA	5.8E-07 <0.1%

Revised Table F-24
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Construction Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated				
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation			
Benzo(a)anthracene	2.33E-01	1.00E+06 P	1.3E-08	2.7E-08	8.3E-11	4.0E-08	0.6%	NA	NA	NA	NA	-	
Benzo(a)pyrene	1.73E-01	1.00E+06 P	9.6E-08	2.0E-07	6.2E-10	2.9E-07	4.8%	NA	NA	NA	NA	-	
Benzo(b)fluoranthene	1.51E-01	1.00E+06 P	8.4E-09	1.7E-08	5.4E-11	2.6E-08	0.4%	NA	NA	NA	NA	-	
Benzo(ghi)perylene	1.34E-01	1.00E+06 P	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Benzo(k)fluoranthene	1.41E-01	1.00E+06 P	7.8E-09	1.6E-08	5.0E-11	2.4E-08	0.4%	NA	NA	NA	NA	-	
Chrysene	3.67E-01	1.00E+06 P	2.0E-09	4.2E-09	1.3E-11	6.3E-09	0.1%	NA	NA	NA	NA	-	
Dibenz(a,h)anthracene	4.10E-02	1.00E+06 P	7.7E-09	1.6E-08	1.6E-10	2.4E-08	0.4%	NA	NA	NA	NA	-	
Fluoranthene	3.49E-01	1.00E+06 P	NA	NA	NA	NA	-	2.8E-06	5.8E-06	NA	8.7E-06	<0.1%	
Fluorene	1.47E+00	5.02E+05 V	NA	NA	NA	NA	-	1.2E-05	2.5E-05	NA	3.7E-05	<0.1%	
Indeno(1,2,3-cd)pyrene	1.08E-01	1.00E+06 P	6.0E-09	1.2E-08	3.9E-11	1.8E-08	0.3%	NA	NA	NA	NA	-	
Naphthalene	3.59E+00	5.49E+04 V	NA	NA	7.2E-09	7.2E-09	0.1%	5.8E-05	1.2E-04	1.7E-03	1.8E-03	0.1%	
Phenanthrene	2.13E+00	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Pyrene	5.58E-01	1.00E+06 P	NA	NA	NA	NA	-	6.0E-06	1.2E-05	NA	1.8E-05	<0.1%	
Pesticides and Herbicides													
4,4-DDE	1.30E-02 m	1.00E+06 P	2.0E-10	1.4E-10	4.1E-12	3.5E-10	<0.1%	NA	NA	NA	NA	-	
Aldrin	1.80E-01 m	1.00E+06 P	1.4E-07	9.8E-08	2.9E-09	2.4E-07	3.9%	1.9E-02	1.3E-02	NA	3.3E-02	2.1%	
Chlordane	1.50E+00 m	1.00E+06 P	9.0E-08	6.2E-08	1.7E-09	1.5E-07	2.5%	9.7E-03	6.7E-03	4.9E-05	1.6E-02	1.0%	
Dieldrin	2.50E-02 m	1.00E+06 P	1.8E-08	1.3E-08	3.8E-10	3.2E-08	0.5%	1.6E-03	1.1E-03	NA	2.7E-03	0.2%	
Polychlorinated Biphenyls (PCBs)													
PCB-1254	1.90E+00 m	1.00E+06 P	1.8E-07	3.6E-07	3.5E-09	5.4E-07	8.8%	1.2E-01	2.5E-01	NA	3.8E-01	23.9%	
PCB-1260	3.06E-01 m	1.00E+06 P	2.8E-08	5.9E-08	5.7E-10	8.7E-08	1.4%	NA	NA	NA	NA	-	
Inorganic Compounds													
Antimony	1.79E+00	1.00E+06 P	NA	NA	NA	NA	-	1.4E-02	-	NA	1.4E-02	0.9%	
Arsenic	5.40E+00	1.00E+06 P	2.4E-06	9.8E-07	5.8E-08	3.4E-06	55.2%	5.8E-02	2.4E-02	8.2E-02	1.6E-01	10.4%	
Barium	2.06E+02	1.00E+06 P	NA	NA	NA	NA	-	3.3E-03	-	9.4E-03	1.3E-02	0.8%	
Beryllium	8.67E-01	1.00E+06 P	NA	NA	6.8E-09	6.8E-09	0.1%	5.6E-04	-	2.8E-02	2.9E-02	1.8%	
Cadmium	4.53E-01	1.00E+06 P	NA	NA	6.2E-09	6.2E-09	0.1%	1.5E-03	8.1E-04	5.2E-03	7.4E-03	0.5%	
Chromium	8.92E+01	1.00E+06 P	NA	NA	NA	NA	-	1.9E-04	-	NA	1.9E-04	<0.1%	
Chromium, Hexavalent	1.12E+00	1.00E+06 P	NA	NA	5.5E-07	5.5E-07	8.9%	1.8E-04	-	1.3E-03	1.5E-03	<0.1%	
Cobalt	1.40E+01	1.00E+06 P	NA	NA	4.1E-07	4.1E-07	6.7%	1.5E-01	-	5.3E-01	6.8E-01	43.4%	
Copper	7.51E+01	1.00E+06 P	NA	NA	NA	NA	-	6.1E-03	-	NA	6.1E-03	0.4%	
Lead	4.52E+02	1.00E+06 P	NA	NA	1.8E-08	1.8E-08	0.3%	NA	NA	NA	NA	-	
Mercury	2.03E+00	1.00E+06 P	NA	NA	NA	NA	-	2.2E-02	-	1.5E-02	3.7E-02	2.4%	
Molybdenum	2.73E+00	1.00E+06 P	NA	NA	NA	NA	-	1.8E-03	-	NA	1.8E-03	0.1%	
Nickel	2.36E+01	1.00E+06 P	NA	NA	2.0E-08	2.0E-08	0.3%	3.8E-03	-	1.1E-01	1.1E-01	7.1%	
Selenium	9.93E-01	1.00E+06 P	NA	NA	NA	NA	-	6.4E-04	-	1.1E-05	6.5E-04	<0.1%	
Silver	9.33E-01 m	1.00E+06 P	NA	NA	NA	NA	-	6.0E-04	-	NA	6.0E-04	<0.1%	
Thallium	8.41E-01 m	1.00E+06 P	NA	NA	NA	NA	-	3.4E-03	-	NA	3.4E-03	0.2%	
Vanadium	5.00E+01	1.00E+06 P	NA	NA	NA	NA	-	2.3E-02	-	NA	2.3E-02	1.5%	
Zinc	1.66E+02	1.00E+06 P	NA	NA	NA	NA	-	1.8E-03	-	NA	1.8E-03	0.1%	

Revised Table F-24
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Construction Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI		
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated					
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
	ELCRo	ELCRd	ELCRI		ELCR			HQo	HQd	HQi		HI		
Total Risk or Hazard			Total ELCR		6E-06	100%		Total HI **		2	100%			
Total Risk or Hazard from Arsenic					3E-06					0.2				
Total Risk or Hazard without Arsenic					3E-06					1				

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

— = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1) / ([\text{VF or PEF}] \times 365 \times \text{RfC})$$

Revised Table F-25
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Percent	Route-Specific Hazard Quotient	Percent			
			Oral	Dermal	Inhalation			Total	Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		HI	
Volatile Organic Compounds (VOCs)													
1,1,1-Trichloroethane	3.80E-03	m	2.17E+03	V	NA	NA	NA	NA	—	4.9E-10	—	3.2E-08	3.2E-08 <0.1%
1,1,2-Trichloroethane	2.60E-03	m	6.36E+03	V	4.8E-12	—	1.2E-11	1.7E-11	<0.1%	1.7E-08	—	NA	1.7E-08 <0.1%
1,2,3-Trichloropropane	5.50E-01	m	1.14E+04	V	9.9E-08	—	NA	9.9E-08	2.9%	2.4E-06	—	NA	2.4E-06 <0.1%
1,2,4-Trichlorobenzene	1.70E-01	m	4.23E+04	V	1.6E-11	—	NA	1.6E-11	<0.1%	4.4E-06	—	3.7E-08	4.4E-06 <0.1%
1,2,4-Trimethylbenzene	1.05E+01		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	9.4E-04	9.4E-04 0.7%
1,2-Dichlorobenzene	2.90E+00	m	1.43E+04	V	NA	NA	NA	NA	—	8.3E-07	—	1.8E-06	2.7E-06 <0.1%
1,2-Dichloropropane	2.20E-02	m	3.52E+03	V	2.0E-11	—	1.1E-10	1.3E-10	<0.1%	NA	NA	8.8E-06	8.8E-06 <0.1%
1,3,5-Trimethylbenzene	1.60E+00		1.15E+04	V	NA	NA	NA	NA	—	8.3E-06	—	4.2E-04	4.3E-04 0.3%
1,4-Dichlorobenzene	4.00E-01	m	1.28E+04	V	5.6E-11	—	6.3E-10	6.9E-10	<0.1%	NA	NA	7.2E-07	7.2E-07 <0.1%
Benzene	6.62E-01		2.68E+03	V	1.7E-09	—	1.3E-08	1.5E-08	0.4%	1.4E-05	—	7.5E-05	8.9E-05 <0.1%
Bromodichloromethane	1.40E-01	m	8.10E+03	V	4.7E-10	—	1.2E-09	1.6E-09	<0.1%	1.8E-06	—	NA	1.8E-06 <0.1%
c-1,2-Dichloroethene	1.75E-02	m	2.85E+03	V	NA	NA	NA	NA	—	4.5E-08	—	NA	4.5E-08 <0.1%
Carbon Disulfide	3.26E-03		1.17E+03	V	NA	NA	NA	NA	—	8.4E-09	—	6.4E-08	7.2E-08 <0.1%
Chloroform	5.91E-03		2.61E+03	V	4.7E-12	—	2.2E-11	2.7E-11	<0.1%	1.5E-07	—	1.4E-07	2.9E-07 <0.1%
Ethylbenzene	2.52E+00		5.29E+03	V	7.2E-10	—	2.2E-09	2.9E-09	<0.1%	6.5E-07	—	4.3E-06	5.0E-06 <0.1%
Iodomethane	5.00E-03	m	1.00E+06	P	NA	NA	NA	NA	—	NA	NA	NA	NA —
Isopropylbenzene	9.90E-01		1.65E+03	V	NA	NA	NA	NA	—	6.4E-07	—	2.7E-05	2.8E-05 <0.1%
Methylene Chloride	5.80E-01	m	2.45E+03	V	2.1E-10	—	4.3E-10	6.4E-10	<0.1%	2.5E-06	—	1.1E-05	1.3E-05 <0.1%
Methyl-t-Butyl Ether (MTBE)	5.15E-03		4.07E+03	V	2.4E-13	—	6.0E-13	8.4E-13	<0.1%	NA	NA	2.9E-09	2.9E-09 <0.1%
n-Butylbenzene	4.53E-01		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
n-Propylbenzene	1.75E+00		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
o-Xylene	3.48E+00		5.16E+03	V	NA	NA	NA	NA	—	4.5E-07	—	1.8E-05	1.8E-05 <0.1%
p/m-Xylene	7.96E+00		3.79E+03	V	NA	NA	NA	NA	—	1.0E-05	—	1.3E-04	1.4E-04 0.1%
p-Isopropyltoluene	4.15E-01		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
sec-Butylbenzene	5.65E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
t-1,2-Dichloroethene	2.00E-03	m	2.28E+03	V	NA	NA	NA	NA	—	2.6E-09	—	2.7E-07	2.7E-07 <0.1%
Tert-Butyl Alcohol (TBA)	4.14E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
tert-Butylbenzene	1.22E-02		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
Tetrachloroethene	1.53E-01	m	2.50E+03	V	2.1E-09	—	6.6E-10	2.8E-09	<0.1%	3.9E-07	—	3.2E-05	3.2E-05 <0.1%
Toluene	8.93E-01		3.90E+03	V	NA	NA	NA	NA	—	2.9E-07	—	1.4E-05	1.4E-05 <0.1%
Trichloroethene	5.63E-02	m	3.20E+03	V	1.9E-11	—	6.4E-11	8.3E-11	<0.1%	NA	NA	5.4E-07	5.4E-07 <0.1%
Vinyl Chloride	1.50E-03	m	1.02E+03	V	1.0E-11	—	2.1E-10	2.2E-10	<0.1%	1.3E-07	—	2.7E-07	4.0E-07 <0.1%
Xylenes, total	1.14E+01		4.39E+03	V	NA	NA	NA	NA	—	1.5E-05	—	6.8E-05	8.2E-05 <0.1%
Semivolatile Organic Compounds (SVOCs)													
1-Methylnaphthalene	1.92E+01		1.63E+05	V	1.4E-08	—	NA	1.4E-08	0.4%	NA	NA	NA	NA —
2-Methylnaphthalene	2.70E+01		1.13E+05	V	NA	NA	NA	NA	—	1.7E-03	—	NA	1.7E-03 1.4%
Acenaphthene	5.01E-01		2.12E+05	V	NA	NA	NA	NA	—	2.2E-07	4.5E-07	NA	6.6E-07 <0.1%
Acenaphthylene	1.50E-01		1.63E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
Anthracene	1.75E-01		7.70E+05	V	NA	NA	NA	NA	—	1.5E-08	3.1E-08	NA	4.6E-08 <0.1%

Revised Table F-25
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Percent	Route-Specific Hazard Quotient	Calculated			
			Oral	Dermal	Inhalation			Total ELCR	Oral	Dermal	Inhalation		
Benzo(a)anthracene	2.33E-01	1.00E+06 P	7.2E-09	1.5E-08	4.7E-11	2.2E-08	0.6%	NA	NA	NA	NA	-	
Benzo(a)pyrene	1.73E-01	1.00E+06 P	5.4E-08	1.1E-07	3.5E-10	1.6E-07	4.8%	NA	NA	NA	NA	-	
Benzo(b)fluoranthene	1.51E-01	1.00E+06 P	4.7E-09	9.7E-09	3.0E-11	1.4E-08	0.4%	NA	NA	NA	NA	-	
Benzo(ghi)perylene	1.34E-01	1.00E+06 P	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Benzo(k)fluoranthene	1.41E-01	1.00E+06 P	4.4E-09	9.0E-09	2.8E-11	1.3E-08	0.4%	NA	NA	NA	NA	-	
Chrysene	3.67E-01	1.00E+06 P	1.1E-09	2.4E-09	7.4E-12	3.5E-09	0.1%	NA	NA	NA	NA	-	
Dibenzo(a,h)anthracene	4.10E-02	1.00E+06 P	4.3E-09	9.0E-09	9.0E-11	1.3E-08	0.4%	NA	NA	NA	NA	-	
Fluoranthene	3.49E-01	1.00E+06 P	NA	NA	NA	NA	-	2.3E-07	4.7E-07	NA	6.9E-07	<0.1%	
Fluorene	1.47E+00	5.02E+05 V	NA	NA	NA	NA	-	9.5E-07	2.0E-06	NA	2.9E-06	<0.1%	
Indeno(1,2,3-cd)pyrene	1.08E-01	1.00E+06 P	3.3E-09	6.9E-09	2.2E-11	1.0E-08	0.3%	NA	NA	NA	NA	-	
Naphthalene	3.59E+00	5.49E+04 V	NA	NA	4.1E-09	4.1E-09	0.1%	4.6E-06	9.6E-06	1.3E-04	1.5E-04	0.1%	
Phenanthrene	2.13E+00	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Pyrene	5.58E-01	1.00E+06 P	NA	NA	NA	NA	-	4.8E-07	1.0E-06	NA	1.5E-06	<0.1%	
Pesticides and Herbicides													
4,4-DDE	1.30E-02 m	1.00E+06 P	1.1E-10	7.9E-11	2.3E-12	2.0E-10	<0.1%	NA	NA	NA	NA	-	
Aldrin	1.80E-01 m	1.00E+06 P	7.9E-08	5.5E-08	1.6E-09	1.4E-07	3.9%	1.5E-03	1.1E-03	NA	2.6E-03	2.1%	
Chlordane	1.50E+00 m	1.00E+06 P	5.0E-08	3.5E-08	9.3E-10	8.6E-08	2.5%	7.7E-04	5.4E-04	3.9E-06	1.3E-03	1.0%	
Dieldrin	2.50E-02 m	1.00E+06 P	1.0E-08	7.1E-09	2.1E-10	1.8E-08	0.5%	1.3E-04	8.9E-05	NA	2.2E-04	0.2%	
Polychlorinated Biphenyls (PCBs)													
PCB-1254	1.90E+00 m	1.00E+06 P	9.8E-08	2.0E-07	2.0E-09	3.0E-07	8.8%	9.8E-03	2.0E-02	NA	3.0E-02	23.9%	
PCB-1260	3.06E-01 m	1.00E+06 P	1.6E-08	3.3E-08	3.2E-10	4.9E-08	1.4%	NA	NA	NA	NA	-	
Inorganic Compounds													
Antimony	1.79E+00	1.00E+06 P	NA	NA	NA	NA	-	1.2E-03	-	NA	1.2E-03	0.9%	
Arsenic	5.40E+00	1.00E+06 P	1.3E-06	5.5E-07	3.3E-08	1.9E-06	55.2%	4.6E-03	1.9E-03	6.6E-03	1.3E-02	10.4%	
Barium	2.06E+02	1.00E+06 P	NA	NA	NA	NA	-	2.7E-04	-	7.5E-04	1.0E-03	0.8%	
Beryllium	8.67E-01	1.00E+06 P	NA	NA	3.8E-09	3.8E-09	0.1%	4.5E-05	-	2.3E-03	2.3E-03	1.8%	
Cadmium	4.53E-01	1.00E+06 P	NA	NA	3.5E-09	3.5E-09	0.1%	1.2E-04	6.5E-05	4.1E-04	6.0E-04	0.5%	
Chromium	8.92E+01	1.00E+06 P	NA	NA	NA	NA	-	1.5E-05	-	NA	1.5E-05	<0.1%	
Chromium, Hexavalent	1.12E+00	1.00E+06 P	NA	NA	3.1E-07	3.1E-07	8.9%	1.4E-05	-	1.0E-04	1.2E-04	<0.1%	
Cobalt	1.40E+01	1.00E+06 P	NA	NA	2.3E-07	2.3E-07	6.7%	1.2E-02	-	4.3E-02	5.5E-02	43.4%	
Copper	7.51E+01	1.00E+06 P	NA	NA	NA	NA	-	4.9E-04	-	NA	4.9E-04	0.4%	
Lead	4.52E+02	1.00E+06 P	NA	NA	9.9E-09	9.9E-09	0.3%	NA	NA	NA	NA	-	
Mercury	2.03E+00	1.00E+06 P	NA	NA	NA	NA	-	1.7E-03	-	1.2E-03	3.0E-03	2.4%	
Molybdenum	2.73E+00	1.00E+06 P	NA	NA	NA	NA	-	1.4E-04	-	NA	1.4E-04	0.1%	
Nickel	2.36E+01	1.00E+06 P	NA	NA	1.1E-08	1.1E-08	0.3%	3.0E-04	-	8.6E-03	8.9E-03	7.1%	
Selenium	9.93E-01	1.00E+06 P	NA	NA	NA	NA	-	5.1E-05	-	9.1E-07	5.2E-05	<0.1%	
Silver	9.33E-01 m	1.00E+06 P	NA	NA	NA	NA	-	4.8E-05	-	NA	4.8E-05	<0.1%	
Thallium	8.41E-01 m	1.00E+06 P	NA	NA	NA	NA	-	2.7E-04	-	NA	2.7E-04	0.2%	
Vanadium	5.00E+01	1.00E+06 P	NA	NA	NA	NA	-	1.8E-03	-	NA	1.8E-03	1.5%	
Zinc	1.66E+02	1.00E+06 P	NA	NA	NA	NA	-	1.4E-04	-	NA	1.4E-04	0.1%	

Revised Table F-25
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Percent	Route-Specific Hazard Quotient	Calculated			
			Oral	Dermal	Inhalation			Total ELCR	Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		HI	
Total Risk or Hazard			Total ELCR			3E-06	100%	Total HI			0.1	100%	
Total Risk or Hazard from Arsenic						2E-06					0.01		
Total Risk or Hazard without Arsenic						2E-06					0.1		

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 20 \times 7 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSD} \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7) / ([\text{VF or PEF}] \times 2,555 \times \text{RfC})$$

Revised Table F-26
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Site Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient					
			Oral	Dermal	Inhalation			Total	Oral	Dermal			
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi		HI	
Volatile Organic Compounds (VOCs)													
1,1,1-Trichloroethane	3.80E-03	m	2.17E+03	V	NA	NA	NA	NA	—	1.9E-09	—	4.0E-07	4.0E-07 <0.1%
1,1,2-Trichloroethane	2.60E-03	m	6.36E+03	V	6.5E-11	—	5.3E-10	6.0E-10	<0.1%	6.4E-07	—	NA	6.4E-07 <0.1%
1,2,3-Trichloropropane	5.50E-01	m	1.14E+04	V	1.3E-06	—	NA	1.3E-06	3.7%	9.0E-05	—	NA	9.0E-05 <0.1%
1,2,4-Trichlorobenzene	1.70E-01	m	4.23E+04	V	2.1E-10	—	NA	2.1E-10	<0.1%	1.7E-05	—	2.3E-04	2.5E-04 <0.1%
1,2,4-Trimethylbenzene	1.05E+01		2.90E+04	V	NA	NA	NA	NA	—	NA	NA	1.2E-02	1.2E-02 2.9%
1,2-Dichlorobenzene	2.90E+00	m	1.43E+04	V	NA	NA	NA	NA	—	3.2E-05	—	2.3E-04	2.6E-04 <0.1%
1,2-Dichloropropane	2.20E-02	m	3.52E+03	V	2.8E-10	—	5.1E-09	5.4E-09	<0.1%	NA	NA	3.6E-04	3.6E-04 <0.1%
1,3,5-Trimethylbenzene	1.60E+00		1.15E+04	V	NA	NA	NA	NA	—	3.1E-05	—	5.3E-03	5.3E-03 1.3%
1,4-Dichlorobenzene	4.00E-01	m	1.28E+04	V	7.5E-10	—	2.8E-08	2.9E-08	<0.1%	NA	NA	9.0E-06	9.0E-06 <0.1%
Benzene	6.62E-01		2.68E+03	V	2.3E-08	—	5.8E-07	6.1E-07	1.7%	1.6E-04	—	9.4E-04	1.1E-03 0.3%
Bromodichloromethane	1.40E-01	m	8.10E+03	V	6.4E-09	—	5.2E-08	5.9E-08	0.2%	6.8E-06	—	NA	6.8E-06 <0.1%
c-1,2-Dichloroethene	1.75E-02	m	2.85E+03	V	NA	NA	NA	NA	—	1.7E-06	—	NA	1.7E-06 <0.1%
Carbon Disulfide	3.26E-03		1.17E+03	V	NA	NA	NA	NA	—	3.2E-08	—	8.0E-07	8.3E-07 <0.1%
Chloroform	5.91E-03		2.61E+03	V	6.4E-11	—	9.8E-10	1.0E-09	<0.1%	5.8E-07	—	1.7E-06	2.3E-06 <0.1%
Ethylbenzene	2.52E+00		5.29E+03	V	9.7E-09	—	9.7E-08	1.1E-07	0.3%	2.5E-05	—	5.4E-05	7.9E-05 <0.1%
Iodomethane	5.00E-03	m	1.32E+09	P	NA	NA	NA	NA	—	NA	NA	NA	NA —
Isopropylbenzene	9.90E-01		1.65E+03	V	NA	NA	NA	NA	—	9.7E-06	—	3.4E-04	3.5E-04 <0.1%
Methylene Chloride	5.80E-01	m	2.45E+03	V	2.8E-09	—	1.9E-08	2.2E-08	<0.1%	9.5E-06	—	1.4E-04	1.4E-04 <0.1%
Methyl-t-Butyl Ether (MTBE)	5.15E-03		4.07E+03	V	3.2E-12	—	2.7E-11	3.0E-11	<0.1%	NA	NA	3.6E-08	3.6E-08 <0.1%
n-Butylbenzene	4.53E-01		7.83E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
n-Propylbenzene	1.75E+00		6.62E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
o-Xylene	3.48E+00		5.16E+03	V	NA	NA	NA	NA	—	1.7E-06	—	2.2E-04	2.2E-04 <0.1%
p/m-Xylene	7.96E+00		3.79E+03	V	NA	NA	NA	NA	—	3.9E-05	—	4.8E-03	4.8E-03 1.2%
p-Isopropyltoluene	4.15E-01		8.17E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
sec-Butylbenzene	5.65E-01		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
t-1,2-Dichloroethene	2.00E-03	m	2.28E+03	V	NA	NA	NA	NA	—	9.8E-08	—	3.3E-06	3.4E-06 <0.1%
Tert-Butyl Alcohol (TBA)	4.14E-02		1.95E+04	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
tert-Butylbenzene	1.22E-02		7.06E+03	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
Tetrachloroethene	1.53E-01	m	2.50E+03	V	2.9E-08	—	2.9E-08	5.8E-08	0.2%	1.5E-05	—	4.0E-04	4.1E-04 0.1%
Toluene	8.93E-01		3.90E+03	V	NA	NA	NA	NA	—	1.1E-05	—	1.7E-04	1.9E-04 <0.1%
Trichloroethene	5.63E-02	m	3.20E+03	V	2.6E-10	—	2.9E-09	3.1E-09	<0.1%	NA	NA	6.7E-06	6.7E-06 <0.1%
Vinyl Chloride	1.50E-03	m	1.02E+03	V	1.4E-10	—	9.4E-09	9.5E-09	<0.1%	4.9E-07	—	3.4E-06	3.8E-06 <0.1%
Xylenes, total	1.14E+01		4.39E+03	V	NA	NA	NA	NA	—	5.6E-05	—	8.4E-04	9.0E-04 0.2%
Semivolatile Organic Compounds (SVOCs)													
1-Methylnaphthalene	1.92E+01		1.63E+05	V	1.9E-07	—	NA	1.9E-07	0.5%	NA	NA	NA	NA —
2-Methylnaphthalene	2.70E+01		1.13E+05	V	NA	NA	NA	NA	—	6.6E-03	—	NA	6.6E-03 1.6%
Acenaphthene	5.01E-01		2.12E+05	V	NA	NA	NA	NA	—	8.2E-06	1.4E-05	NA	2.2E-05 <0.1%
Acenaphthylene	1.50E-01		1.63E+05	V	NA	NA	NA	NA	—	NA	NA	NA	NA —
Anthracene	1.75E-01		7.70E+05	V	NA	NA	NA	NA	—	5.7E-07	9.8E-07	NA	1.5E-06 <0.1%

Revised Table F-26
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Site Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI	
			Route-Specific Risk					Percent	Route-Specific Hazard Quotient	Calculated			
			Oral	Dermal	Inhalation			Total ELCR	Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi			
Benzo(a)anthracene	2.33E-01	1.32E+09 P	9.7E-08	1.7E-07	1.6E-12	2.6E-07	0.7%	NA	NA	NA	NA	-	
Benzo(a)pyrene	1.73E-01	1.32E+09 P	7.2E-07	1.2E-06	1.2E-11	2.0E-06	5.4%	NA	NA	NA	NA	-	
Benzo(b)fluoranthene	1.51E-01	1.32E+09 P	6.3E-08	1.1E-07	1.0E-12	1.7E-07	0.5%	NA	NA	NA	NA	-	
Benzo(ghi)perylene	1.34E-01	1.32E+09 P	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Benzo(k)fluoranthene	1.41E-01	1.32E+09 P	5.9E-08	1.0E-07	9.5E-13	1.6E-07	0.4%	NA	NA	NA	NA	-	
Chrysene	3.67E-01	1.32E+09 P	1.5E-08	2.6E-08	2.5E-13	4.2E-08	0.1%	NA	NA	NA	NA	-	
Dibenz(a,h)anthracene	4.10E-02	1.32E+09 P	5.9E-08	1.0E-07	3.0E-12	1.6E-07	0.4%	NA	NA	NA	NA	-	
Fluoranthene	3.49E-01	1.32E+09 P	NA	NA	NA	NA	-	8.5E-06	1.5E-05	NA	2.3E-05	<0.1%	
Fluorene	1.47E+00	5.02E+05 V	NA	NA	NA	NA	-	3.6E-05	6.2E-05	NA	9.8E-05	<0.1%	
Indeno(1,2,3-cd)pyrene	1.08E-01	1.32E+09 P	4.5E-08	7.7E-08	7.3E-13	1.2E-07	0.3%	NA	NA	NA	NA	-	
Naphthalene	3.59E+00	5.49E+04 V	NA	NA	1.8E-07	1.8E-07	0.5%	1.8E-04	3.0E-04	1.7E-03	2.1E-03	0.5%	
Phenanthrene	2.13E+00	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-	
Pyrene	5.58E-01	1.32E+09 P	NA	NA	NA	NA	-	1.8E-05	3.1E-05	NA	4.9E-05	<0.1%	
Pesticides and Herbicides													
4,4-DDE	1.30E-02 m	1.32E+09 P	1.5E-09	8.8E-10	7.8E-14	2.4E-09	<0.1%	NA	NA	NA	NA	-	
Aldrin	1.80E-01 m	1.32E+09 P	1.1E-06	6.1E-07	5.4E-11	1.7E-06	4.6%	5.9E-03	3.3E-03	NA	9.2E-03	2.3%	
Chlordane	1.50E+00 m	1.32E+09 P	6.8E-07	3.9E-07	3.2E-11	1.1E-06	2.9%	2.9E-03	1.7E-03	3.7E-07	4.6E-03	1.1%	
Dieldrin	2.50E-02 m	1.32E+09 P	1.4E-07	8.0E-08	7.1E-12	2.2E-07	0.6%	4.9E-04	2.8E-04	NA	7.7E-04	0.2%	
Polychlorinated Biphenyls (PCBs)													
PCB-1254	1.90E+00 m	1.32E+09 P	1.3E-06	2.3E-06	6.7E-11	3.6E-06	9.8%	9.3E-02	1.6E-01	NA	2.5E-01	61.5%	
PCB-1260	3.06E-01 m	1.32E+09 P	2.1E-07	3.7E-07	1.1E-11	5.8E-07	1.6%	NA	NA	NA	NA	-	
Inorganic Compounds													
Antimony	1.79E+00	1.32E+09 P	NA	NA	NA	NA	-	4.4E-03	-	NA	4.4E-03	1.1%	
Arsenic	5.40E+00	1.32E+09 P	1.8E-05	6.1E-06	1.1E-09	2.4E-05	65.4%	1.8E-02	6.0E-03	6.2E-05	2.4E-02	5.8%	
Barium	2.06E+02	1.32E+09 P	NA	NA	NA	NA	-	1.0E-03	-	7.1E-05	1.1E-03	0.3%	
Beryllium	8.67E-01	1.32E+09 P	NA	NA	1.3E-10	1.3E-10	<0.1%	4.2E-04	-	2.1E-05	4.5E-04	0.1%	
Cadmium	4.53E-01	1.32E+09 P	NA	NA	1.2E-10	1.2E-10	<0.1%	4.4E-04	2.0E-04	3.9E-06	6.5E-04	0.2%	
Chromium	8.92E+01	1.32E+09 P	NA	NA	NA	NA	-	5.8E-05	-	NA	5.8E-05	<0.1%	
Chromium, Hexavalent	1.12E+00	1.32E+09 P	NA	NA	1.0E-08	1.0E-08	<0.1%	3.6E-04	-	9.7E-07	3.7E-04	<0.1%	
Cobalt	1.40E+01	1.32E+09 P	NA	NA	7.8E-09	7.8E-09	<0.1%	4.6E-02	-	4.0E-04	4.6E-02	11.3%	
Copper	7.51E+01	1.32E+09 P	NA	NA	NA	NA	-	1.8E-03	-	NA	1.8E-03	0.4%	
Lead	4.52E+02	1.32E+09 P	NA	NA	3.4E-10	3.4E-10	<0.1%	NA	NA	NA	NA	-	
Mercury	2.03E+00	1.32E+09 P	NA	NA	NA	NA	-	6.6E-03	-	1.2E-05	6.6E-03	1.6%	
Molybdenum	2.73E+00	1.32E+09 P	NA	NA	NA	NA	-	5.3E-04	-	NA	5.3E-04	0.1%	
Nickel	2.36E+01	1.32E+09 P	NA	NA	3.8E-10	3.8E-10	<0.1%	1.2E-03	-	8.1E-05	1.2E-03	0.3%	
Selenium	9.93E-01	1.32E+09 P	NA	NA	NA	NA	-	1.9E-04	-	8.6E-09	1.9E-04	<0.1%	
Silver	9.33E-01 m	1.32E+09 P	NA	NA	NA	NA	-	1.8E-04	-	NA	1.8E-04	<0.1%	
Thallium	8.41E-01 m	1.32E+09 P	NA	NA	NA	NA	-	1.3E-02	-	NA	1.3E-02	3.1%	
Vanadium	5.00E+01	1.32E+09 P	NA	NA	NA	NA	-	7.0E-03	-	NA	7.0E-03	1.7%	
Zinc	1.66E+02	1.32E+09 P	NA	NA	NA	NA	-	5.4E-04	-	NA	5.4E-04	0.1%	

Revised Table F-26
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 3

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: **Future**
 Receptor Population: **Site Worker**
 Receptor Age: **Adult**

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Total ELCR	NON-CANCER HAZARD INDEX			Calculated Hazard Index	Total HI
			Route-Specific Risk					Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRI	ELCR	ELCR	HQo	HQd	HQi		
Total Risk or Hazard			Total ELCR			4E-05	100%	Total HI			0.4	100%
Total Risk or Hazard from Arsenic						2E-05					0.02	
Total Risk or Hazard without Arsenic						1E-05					0.4	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

— = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F-31
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: [Current/Future](#)
 Receptor Population: [Site Worker](#)
 Receptor Age: [Adult](#)

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Volatile Organic Compounds (VOCs)												
1,2,4-Trimethylbenzene	9.31E+00	2.90E+04	V	NA	NA	NA	–	NA	NA	1.0E-02	1.0E-02 2.9%	
1,2-Dichlorobenzene	7.40E-03	m	1.43E+04	V	NA	NA	NA	–	8.0E-08	–	5.9E-07 6.7E-07 <0.1%	
1,2-Dichloropropane	–	–	–	–	–	–	–	–	–	–	–	
1,3,5-Trimethylbenzene	2.10E+00	m	1.15E+04	V	NA	NA	NA	–	4.1E-05	–	6.9E-03 7.0E-03 1.9%	
1,4-Dichlorobenzene	5.20E-03	m	1.28E+04	V	9.8E-12	–	3.7E-10	3.8E-10 <0.1%	NA	NA	1.2E-07 1.2E-07 <0.1%	
Benzene	5.84E-01		2.68E+03	V	2.0E-08	–	5.1E-07	5.4E-07 1.3%	1.4E-04	–	8.3E-04 9.7E-04 0.3%	
Carbon Disulfide	1.90E-02	m	1.17E+03	V	NA	NA	NA	–	1.9E-07	–	4.6E-06 4.8E-06 <0.1%	
Chloroform	2.65E-01		2.61E+03	V	2.9E-09	–	4.4E-08	4.7E-08 0.1%	2.6E-05	–	7.7E-05 1.0E-04 <0.1%	
Ethylbenzene	5.96E-01		5.29E+03	V	2.3E-09	–	2.3E-08	2.5E-08 <0.1%	5.8E-06	–	1.3E-05 1.9E-05 <0.1%	
Isopropylbenzene	1.74E-01		1.65E+03	V	NA	NA	NA	–	1.7E-06	–	6.0E-05 6.2E-05 <0.1%	
n-Butylbenzene	4.97E-01		7.83E+03	V	NA	NA	NA	–	NA	NA	NA	
n-Propylbenzene	2.89E-01		6.62E+03	V	NA	NA	NA	–	NA	NA	NA	
o-Xylene	1.97E-01		5.16E+03	V	NA	NA	NA	–	9.7E-08	–	1.2E-05 1.3E-05 <0.1%	
p/m-Xylene	4.35E-01		3.79E+03	V	NA	NA	NA	–	2.1E-06	–	2.6E-04 2.6E-04 <0.1%	
p-Isopropyltoluene	3.20E+00	m	8.17E+03	V	NA	NA	NA	–	NA	NA	NA	
sec-Butylbenzene	1.91E-01		7.06E+03	V	NA	NA	NA	–	NA	NA	NA	
Styrene	–	–	–	–	–	–	–	–	–	–	–	
Tert-Butyl Alcohol (TBA)	8.20E-02	m	1.95E+04	V	NA	NA	NA	–	NA	NA	NA	
tert-Butylbenzene	2.80E-01	m	7.06E+03	V	NA	NA	NA	–	NA	NA	NA	
Tetrachloroethene	4.00E-02	m	2.50E+03	V	7.5E-09	–	7.7E-09	1.5E-08 <0.1%	3.9E-06	–	1.0E-04 1.1E-04 <0.1%	
Toluene	2.24E-01		3.90E+03	V	NA	NA	NA	–	2.7E-06	–	4.4E-05 4.6E-05 <0.1%	
Xylenes, total	6.27E-01		4.39E+03	V	NA	NA	NA	–	3.1E-06	–	4.7E-05 5.0E-05 <0.1%	
Semivolatile Organic Compounds (SVOCs)												
1-Methylnaphthalene	2.73E+01		1.63E+05	V	2.8E-07	–	NA	2.8E-07 0.7%	NA	NA	NA	
2-Methylnaphthalene	3.56E+01		1.13E+05	V	NA	NA	NA	–	8.7E-03	–	NA	
Acenaphthene	3.85E+00		2.12E+05	V	NA	NA	NA	–	6.3E-05	1.1E-04	NA	
Acenaphthylene	3.80E-01	m	1.63E+05	V	NA	NA	NA	–	NA	NA	NA	
Anthracene	1.52E-01		7.70E+05	V	NA	NA	NA	–	5.0E-07	8.5E-07	NA	
Benzo(a)anthracene	1.69E-01		1.32E+09	P	7.1E-08	1.2E-07	1.1E-12	1.9E-07 0.5%	NA	NA	NA	
Benzo(a)pyrene	2.32E-01		1.32E+09	P	9.7E-07	1.7E-06	1.6E-11	2.6E-06 6.5%	NA	NA	NA	
Benzo(b)fluoranthene	1.54E-01		1.32E+09	P	6.5E-08	1.1E-07	1.0E-12	1.8E-07 0.4%	NA	NA	NA	
Benzo(ghi)perylene	2.77E-01		1.32E+09	P	NA	NA	NA	–	NA	NA	NA	
Benzo(k)fluoranthene	5.20E-01	m	1.32E+09	P	2.2E-07	3.7E-07	3.5E-12	5.9E-07 1.5%	NA	NA	NA	

Revised Table F-31
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Current/Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index			
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI	
Chrysene	3.71E-01	1.32E+09 P	1.6E-08	2.7E-08	2.5E-13	4.2E-08	0.1%	NA	NA	NA	NA –	
Dibenz(a,h)anthracene	6.20E-01 m	1.32E+09 P	8.9E-07	1.5E-06	4.6E-11	2.4E-06	6.0%	NA	NA	NA	NA –	
Fluoranthene	4.01E-01	1.32E+09 P	NA	NA	NA	NA	–	9.8E-06	1.7E-05	NA	2.7E-05 <0.1%	
Fluorene	4.24E+00	5.02E+05 V	NA	NA	NA	NA	–	1.0E-04	1.8E-04	NA	2.8E-04 <0.1%	
Indeno(1,2,3-cd)pyrene	1.23E-01	1.32E+09 P	5.2E-08	8.8E-08	8.4E-13	1.4E-07	0.3%	NA	NA	NA	NA –	
Naphthalene	2.47E-01	5.49E+04 V	NA	NA	1.2E-08	1.2E-08	<0.1%	1.2E-05	2.1E-05	1.1E-04	1.5E-04 <0.1%	
Phenanthrene	5.86E+01	9.92E+05 V	NA	NA	NA	NA	–	NA	NA	NA	NA –	
Pyrene	5.54E+00	1.32E+09 P	NA	NA	NA	NA	–	1.8E-04	3.1E-04	NA	4.9E-04 0.1%	
Polychlorinated Biphenyls (PCBs)												
PCB-1254	7.40E-01 m	1.32E+09 P	5.2E-07	8.8E-07	2.6E-11	1.4E-06	3.5%	3.6E-02	6.2E-02	NA	9.8E-02 27.3%	
Inorganic Compounds												
Antimony	2.09E+00	1.32E+09 P	NA	NA	NA	NA	–	5.1E-03	–	NA	5.1E-03 1.4%	
Arsenic	7.19E+00	1.32E+09 P	2.4E-05	8.1E-06	1.5E-09	3.2E-05	78.9%	2.3E-02	8.0E-03	8.3E-05	3.2E-02 8.8%	
Barium	2.00E+02	1.32E+09 P	NA	NA	NA	NA	–	9.8E-04	–	6.9E-05	1.0E-03 0.3%	
Beryllium	6.43E-01	1.32E+09 P	NA	NA	9.5E-11	9.5E-11	<0.1%	3.1E-04	–	1.6E-05	3.3E-04 <0.1%	
Cadmium	7.40E-01	1.32E+09 P	NA	NA	1.9E-10	1.9E-10	<0.1%	7.2E-04	3.3E-04	6.4E-06	1.1E-03 0.3%	
Chromium	6.60E-02	1.32E+09 P	NA	NA	NA	NA	–	4.3E-08	–	NA	4.3E-08 <0.1%	
Cobalt	1.23E+01	1.32E+09 P	NA	NA	6.9E-09	6.9E-09	<0.1%	4.0E-02	–	3.6E-04	4.1E-02 11.3%	
Copper	1.02E+02	1.32E+09 P	NA	NA	NA	NA	–	2.5E-03	–	NA	2.5E-03 0.7%	
Lead	2.16E+02	1.32E+09 P	NA	NA	1.6E-10	1.6E-10	<0.1%	NA	NA	NA	NA –	
Mercury	2.63E+01	1.32E+09 P	NA	NA	NA	NA	–	8.6E-02	–	1.5E-04	8.6E-02 23.8%	
Molybdenum	2.68E+00	1.32E+09 P	NA	NA	NA	NA	–	5.2E-04	–	NA	5.2E-04 0.1%	
Nickel	2.24E+01	1.32E+09 P	NA	NA	3.6E-10	3.6E-10	<0.1%	1.1E-03	–	7.8E-05	1.2E-03 0.3%	
Selenium	1.22E+00 m	1.32E+09 P	NA	NA	NA	NA	–	2.4E-04	–	1.1E-08	2.4E-04 <0.1%	
Thallium	3.48E+00	1.32E+09 P	NA	NA	NA	NA	–	5.2E-02	–	NA	5.2E-02 14.6%	
Vanadium	4.45E+01	1.32E+09 P	NA	NA	NA	NA	–	6.2E-03	–	NA	6.2E-03 1.7%	
Zinc	1.30E+03	1.32E+09 P	NA	NA	NA	NA	–	4.2E-03	–	NA	4.2E-03 1.2%	

Revised Table F-31
Risk and Hazard Index Calculations for Commercial/Industrial Worker Receptor
from Exposure to Surface Soil (0- to 2-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: [Current/Future](#)
 Receptor Population: [Site Worker](#)
 Receptor Age: [Adult](#)

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent HI
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total Hazard Index	
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI
Total Risk or Hazard			Total ELCR		4E-05	100%	Total HI		0.4	100%	
Total Risk or Hazard from Arsenic					3E-05				0.03		
Total Risk or Hazard without Arsenic					9E-06				0.3		

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$

Revised Table F-34
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,2,4-Trimethylbenzene	7.33E+00	2.90E+04 V	NA	NA	NA	NA	–	NA	NA	8.2E-03	8.2E-03 0.5%			
1,2-Dichlorobenzene	7.40E-03 m	1.43E+04 V	NA	NA	NA	NA	–	2.7E-08	–	5.9E-08	8.6E-08 <0.1%			
1,2-Dichloropropane	2.00E+00 m	3.52E+03 V	3.3E-09	–	1.9E-08	2.2E-08	0.5%	NA	NA	1.0E-02	1.0E-02 0.7%			
1,3,5-Trimethylbenzene	1.05E+00	1.15E+04 V	NA	NA	NA	NA	–	6.8E-05	–	3.5E-03	3.5E-03 0.2%			
1,4-Dichlorobenzene	5.20E-03 m	1.28E+04 V	1.3E-12	–	1.5E-11	1.6E-11	<0.1%	NA	NA	1.2E-07	1.2E-07 <0.1%			
2-Hexanone	1.63E-03 m	1.53E+04 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Benzene	1.14E+00	2.68E+03 V	5.3E-09	–	4.0E-08	4.5E-08	0.9%	3.1E-04	–	1.6E-03	1.9E-03 0.1%			
Carbon Disulfide	1.90E-02 m	1.17E+03 V	NA	NA	NA	NA	–	6.1E-07	–	4.6E-06	5.3E-06 <0.1%			
Chloroform	1.14E-01	2.61E+03 V	1.6E-10	–	7.6E-10	9.2E-10	<0.1%	3.7E-05	–	3.3E-05	7.0E-05 <0.1%			
Ethylbenzene	1.16E+00	5.29E+03 V	5.9E-10	–	1.8E-09	2.4E-09	<0.1%	3.8E-06	–	2.5E-05	2.9E-05 <0.1%			
Iodomethane	2.25E-03 m	1.00E+06 P	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Isopropylbenzene	3.94E-01	1.65E+03 V	NA	NA	NA	NA	–	3.2E-06	–	1.4E-04	1.4E-04 <0.1%			
Methyl-t-Butyl Ether (MTBE)	2.85E+00 m	4.07E+03 V	2.4E-10	–	5.9E-10	8.3E-10	<0.1%	NA	NA	2.0E-05	2.0E-05 <0.1%			
n-Butylbenzene	3.65E-01	7.83E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
n-Propylbenzene	4.95E-01	6.62E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
o-Xylene	7.33E-01	5.16E+03 V	NA	NA	NA	NA	–	1.2E-06	–	4.6E-05	4.7E-05 <0.1%			
p/m-Xylene	8.96E+00	3.79E+03 V	NA	NA	NA	NA	–	1.4E-04	–	1.8E-03	1.9E-03 0.1%			
p-Isopropyltoluene	3.74E-01	8.17E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
sec-Butylbenzene	2.33E-01	7.06E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Styrene	2.50E-01 m	1.32E+04 V	NA	NA	NA	NA	–	4.0E-07	–	4.8E-06	5.2E-06 <0.1%			
Tert-Butyl Alcohol (TBA)	2.09E-02	1.95E+04 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
tert-Butylbenzene	2.80E-01 m	7.06E+03 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Tetrachloroethene	4.00E-02 m	2.50E+03 V	1.0E-09	–	3.1E-10	1.3E-09	<0.1%	1.3E-06	–	1.0E-04	1.1E-04 <0.1%			
Toluene	4.58E-01	3.90E+03 V	NA	NA	NA	NA	–	1.9E-06	–	8.9E-05	9.1E-05 <0.1%			
Vinyl Acetate	9.80E-03 m	4.69E+03 V	NA	NA	NA	NA	–	3.2E-08	–	2.4E-06	2.4E-06 <0.1%			
Xylenes, total	9.19E+00	4.39E+03 V	NA	NA	NA	NA	–	1.5E-04	–	6.8E-04	8.3E-04 <0.1%			
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.19E+01	1.63E+05 V	2.9E-08	–	NA	2.9E-08	0.6%	NA	NA	NA	NA –			
2-Methylnaphthalene	2.93E+01	1.13E+05 V	NA	NA	NA	NA	–	2.4E-02	–	NA	2.4E-02 1.6%			
Acenaphthene	3.97E+00	2.12E+05 V	NA	NA	NA	NA	–	2.1E-05	4.4E-05	NA	6.6E-05 <0.1%			
Acenaphthylene	6.62E-02	1.63E+05 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Anthracene	1.39E-01	7.70E+05 V	NA	NA	NA	NA	–	1.5E-07	3.1E-07	NA	4.6E-07 <0.1%			
Benzo(a)anthracene	1.26E-01	1.00E+06 P	7.0E-09	1.4E-08	4.5E-11	2.1E-08	0.4%	NA	NA	NA	NA –			

Revised Table F-34
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m ³ /kg)	CANCER RISK				Percent Total ELCR	NON-CANCER HAZARD INDEX				Percent Total HI		
			Route-Specific Risk			Calculated Risk		Route-Specific Hazard Quotient						
			Oral	Dermal	Inhalation			Oral	Dermal	Inhalation				
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Benzo(a)pyrene	7.23E-02	1.00E+06 P	4.0E-08	8.3E-08	2.6E-10	1.2E-07	2.6%	NA	NA	NA	NA	-		
Benzo(b)fluoranthene	4.25E-02	1.00E+06 P	2.4E-09	4.9E-09	1.5E-11	7.3E-09	0.2%	NA	NA	NA	NA	-		
Benzo(ghi)perylene	1.10E-01	1.00E+06 P	NA	NA	NA	NA	-	NA	NA	NA	NA	-		
Benzo(k)fluoranthene	3.70E-02	1.00E+06 P	2.0E-09	4.2E-09	1.3E-11	6.3E-09	0.1%	NA	NA	NA	NA	-		
Chrysene	4.69E-01	1.00E+06 P	2.6E-09	5.4E-09	1.7E-11	8.0E-09	0.2%	NA	NA	NA	NA	-		
Dibenzo(a,h)anthracene	5.91E-02	1.00E+06 P	1.1E-08	2.3E-08	2.3E-10	3.5E-08	0.7%	NA	NA	NA	NA	-		
Fluoranthene	1.56E-01	1.00E+06 P	NA	NA	NA	NA	-	1.3E-06	2.6E-06	NA	3.9E-06	<0.1%		
Fluorene	4.70E+00	5.02E+05 V	NA	NA	NA	NA	-	3.8E-05	7.9E-05	NA	1.2E-04	<0.1%		
Indeno(1,2,3-cd)pyrene	3.55E-02	1.00E+06 P	2.0E-09	4.1E-09	1.3E-11	6.0E-09	0.1%	NA	NA	NA	NA	-		
Naphthalene	1.80E+00	5.49E+04 V	NA	NA	3.6E-09	3.6E-09	<0.1%	2.9E-05	6.0E-05	8.3E-04	9.2E-04	<0.1%		
Phenanthrene	1.60E+01	9.92E+05 V	NA	NA	NA	NA	-	NA	NA	NA	NA	-		
Pyrene	2.41E+00	1.00E+06 P	NA	NA	NA	NA	-	2.6E-05	5.4E-05	NA	8.0E-05	<0.1%		
Polychlorinated Biphenyls (PCBs)														
PCB-1254	7.40E-01 m	1.00E+06 P	6.8E-08	1.4E-07	1.4E-09	2.1E-07	4.4%	4.8E-02	9.9E-02	NA	1.5E-01	9.8%		
Inorganic Compounds														
Antimony	2.44E+00	1.00E+06 P	NA	NA	NA	NA	-	2.0E-02	-	NA	2.0E-02	1.3%		
Arsenic	5.55E+00	1.00E+06 P	2.4E-06	1.0E-06	6.0E-08	3.5E-06	72.1%	6.0E-02	2.5E-02	8.4E-02	1.7E-01	11.2%		
Barium	1.86E+02	1.00E+06 P	NA	NA	NA	NA	-	3.0E-03	-	8.5E-03	1.1E-02	0.8%		
Beryllium	9.90E-01	1.00E+06 P	NA	NA	7.7E-09	7.7E-09	0.2%	6.4E-04	-	3.2E-02	3.3E-02	2.2%		
Cadmium	4.71E-01	1.00E+06 P	NA	NA	6.5E-09	6.5E-09	0.1%	1.5E-03	8.4E-04	5.4E-03	7.7E-03	0.5%		
Chromium	4.70E+01	1.00E+06 P	NA	NA	NA	NA	-	1.0E-04	-	NA	1.0E-04	<0.1%		
Chromium, Hexavalent	7.40E-01 m	1.00E+06 P	NA	NA	3.6E-07	3.6E-07	7.5%	1.2E-04	-	8.4E-04	9.6E-04	<0.1%		
Cobalt	1.43E+01	1.00E+06 P	NA	NA	4.2E-07	4.2E-07	8.7%	1.5E-01	-	5.4E-01	7.0E-01	46.4%		
Copper	7.59E+01	1.00E+06 P	NA	NA	NA	NA	-	6.1E-03	-	NA	6.1E-03	0.4%		
Lead	1.60E+02	1.00E+06 P	NA	NA	6.3E-09	6.3E-09	0.1%	NA	NA	NA	NA	-		
Mercury	1.08E+01	1.00E+06 P	NA	NA	NA	NA	-	1.2E-01	-	8.2E-02	2.0E-01	13.1%		
Molybdenum	1.73E+00	1.00E+06 P	NA	NA	NA	NA	-	1.1E-03	-	NA	1.1E-03	<0.1%		
Nickel	2.37E+01	1.00E+06 P	NA	NA	2.0E-08	2.0E-08	0.4%	3.8E-03	-	1.1E-01	1.1E-01	7.5%		
Selenium	2.14E+00 m	1.00E+06 P	NA	NA	NA	NA	-	1.4E-03	-	2.4E-05	1.4E-03	<0.1%		
Thallium	3.32E+00	1.00E+06 P	NA	NA	NA	NA	-	1.3E-02	-	NA	1.3E-02	0.9%		
Vanadium	5.42E+01	1.00E+06 P	NA	NA	NA	NA	-	2.5E-02	-	NA	2.5E-02	1.7%		
Zinc	7.54E+02	1.00E+06 P	NA	NA	NA	NA	-	8.1E-03	-	NA	8.1E-03	0.5%		

Revised Table F-34
Risk and Hazard Index Calculations for Construction Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Total	Route-Specific Hazard Quotient	Calculated Hazard Index		
			Oral	Dermal	Inhalation			ELCR	HQo	HQd	HQi	
			ELCRo	ELCRd	ELCRi	ELCR			HQo	HQd	HQi	HI
Total Risk or Hazard			Total ELCR			5E-06	100%	Total HI **			2	100%
Total Risk or Hazard from Arsenic						3E-06					0.2	
Total Risk or Hazard without Arsenic						1E-06					1	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 250 \times 1) / (1,000,000 \times 70 \times 365 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 1) / ([\text{VF or PEF}] \times 365 \times \text{RfC})$$

Revised Table F-35
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi	HI			
Volatile Organic Compounds (VOCs)														
1,2,4-Trimethylbenzene	7.33E+00	2.90E+04	V	NA	NA	NA	—	NA	NA	6.6E-04	6.6E-04 0.5%			
1,2-Dichlorobenzene	7.40E-03	m	1.43E+04	V	NA	NA	NA	—	2.1E-09	—	4.7E-09 6.8E-09 <0.1%			
1,2-Dichloropropane	2.00E+00	m	3.52E+03	V	1.9E-09	—	1.0E-08	1.2E-08 0.5%	NA	NA	8.0E-04 8.0E-04 0.7%			
1,3,5-Trimethylbenzene	1.05E+00		1.15E+04	V	NA	NA	NA	—	5.4E-06	—	2.8E-04 2.8E-04 0.2%			
1,4-Dichlorobenzene	5.20E-03	m	1.28E+04	V	7.3E-13	—	8.2E-12	8.9E-12 <0.1%	NA	NA	9.3E-09 9.3E-09 <0.1%			
2-Hexanone	1.63E-03	m	1.53E+04	V	NA	NA	NA	—	NA	NA	NA NA —			
Benzene	1.14E+00		2.68E+03	V	2.9E-09	—	2.2E-08	2.5E-08 0.9%	2.5E-05	—	1.3E-04 1.5E-04 0.1%			
Carbon Disulfide	1.90E-02	m	1.17E+03	V	NA	NA	NA	—	4.9E-08	—	3.7E-07 4.2E-07 <0.1%			
Chloroform	1.14E-01		2.61E+03	V	9.1E-11	—	4.2E-10	5.1E-10 <0.1%	2.9E-06	—	2.7E-06 5.6E-06 <0.1%			
Ethylbenzene	1.16E+00		5.29E+03	V	3.3E-10	—	1.0E-09	1.3E-09 <0.1%	3.0E-07	—	2.0E-06 2.3E-06 <0.1%			
Iodomethane	2.25E-03	m	1.00E+06	P	NA	NA	NA	—	NA	NA	NA NA —			
Isopropylbenzene	3.94E-01		1.65E+03	V	NA	NA	NA	—	2.5E-07	—	1.1E-05 1.1E-05 <0.1%			
Methyl-t-Butyl Ether (MTBE)	2.85E+00	m	4.07E+03	V	1.3E-10	—	3.3E-10	4.7E-10 <0.1%	NA	NA	1.6E-06 1.6E-06 <0.1%			
n-Butylbenzene	3.65E-01		7.83E+03	V	NA	NA	NA	—	NA	NA	NA NA —			
n-Propylbenzene	4.95E-01		6.62E+03	V	NA	NA	NA	—	NA	NA	NA NA —			
o-Xylene	7.33E-01		5.16E+03	V	NA	NA	NA	—	9.5E-08	—	3.7E-06 3.8E-06 <0.1%			
p/m-Xylene	8.96E+00		3.79E+03	V	NA	NA	NA	—	1.2E-05	—	1.4E-04 1.6E-04 0.1%			
p-Isopropyltoluene	3.74E-01		8.17E+03	V	NA	NA	NA	—	NA	NA	NA NA —			
sec-Butylbenzene	2.33E-01		7.06E+03	V	NA	NA	NA	—	NA	NA	NA NA —			
Styrene	2.50E-01	m	1.32E+04	V	NA	NA	NA	—	3.2E-08	—	3.9E-07 4.2E-07 <0.1%			
Tert-Butyl Alcohol (TBA)	2.09E-02		1.95E+04	V	NA	NA	NA	—	NA	NA	NA NA —			
tert-Butylbenzene	2.80E-01	m	7.06E+03	V	NA	NA	NA	—	NA	NA	NA NA —			
Tetrachloroethene	4.00E-02	m	2.50E+03	V	5.6E-10	—	1.7E-10	7.3E-10 <0.1%	1.0E-07	—	8.3E-06 8.4E-06 <0.1%			
Toluene	4.58E-01		3.90E+03	V	NA	NA	NA	—	1.5E-07	—	7.2E-06 7.3E-06 <0.1%			
Vinyl Acetate	9.80E-03	m	4.69E+03	V	NA	NA	NA	—	2.5E-09	—	1.9E-07 1.9E-07 <0.1%			
Xylenes, total	9.19E+00		4.39E+03	V	NA	NA	NA	—	1.2E-05	—	5.5E-05 6.6E-05 <0.1%			
Semivolatile Organic Compounds (SVOCs)														
1-Methylnaphthalene	2.19E+01		1.63E+05	V	1.6E-08	—	NA	1.6E-08 0.6%	NA	NA	NA NA —			
2-Methylnaphthalene	2.93E+01		1.13E+05	V	NA	NA	NA	—	1.9E-03	—	NA 1.9E-03 1.6%			
Acenaphthene	3.97E+00		2.12E+05	V	NA	NA	NA	—	1.7E-06	3.5E-06	NA 5.2E-06 <0.1%			
Acenaphthylene	6.62E-02		1.63E+05	V	NA	NA	NA	—	NA	NA	NA NA —			
Anthracene	1.39E-01		7.70E+05	V	NA	NA	NA	—	1.2E-08	2.5E-08	NA 3.7E-08 <0.1%			
Benzo(a)anthracene	1.26E-01		1.00E+06	P	3.9E-09	8.1E-09	2.5E-11	1.2E-08 0.4%	NA	NA	NA NA —			
Benzo(a)pyrene	7.23E-02		1.00E+06	P	2.2E-08	4.6E-08	1.5E-10	6.9E-08 2.6%	NA	NA	NA NA —			
Benzo(b)fluoranthene	4.25E-02		1.00E+06	P	1.3E-09	2.7E-09	8.5E-12	4.1E-09 0.2%	NA	NA	NA NA —			

Revised Table F-35
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: **Future**
 Receptor Population: **Utility/Trench Worker**
 Receptor Age: **Adult**

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi	HI			
Benzo(ghi)perylene	1.10E-01	1.00E+06	P	NA	NA	NA	—	NA	NA	NA	NA			
Benzo(k)fluoranthene	3.70E-02	1.00E+06	P	1.1E-09	2.4E-09	7.4E-12	3.5E-09	0.1%	NA	NA	NA			
Chrysene	4.69E-01	1.00E+06	P	1.5E-09	3.0E-09	9.4E-12	4.5E-09	0.2%	NA	NA	NA			
Dibenzo(a,h)anthracene	5.91E-02	1.00E+06	P	6.3E-09	1.3E-08	1.3E-10	1.9E-08	0.7%	NA	NA	NA			
Fluoranthene	1.56E-01	1.00E+06	P	NA	NA	NA	NA	—	1.0E-07	2.1E-07	NA			
Fluorene	4.70E+00	5.02E+05	V	NA	NA	NA	NA	—	3.0E-06	6.3E-06	NA			
Indeno(1,2,3-cd)pyrene	3.55E-02	1.00E+06	P	1.1E-09	2.3E-09	7.1E-12	3.4E-09	0.1%	NA	NA	NA			
Naphthalene	1.80E+00	5.49E+04	V	NA	NA	2.0E-09	2.0E-09	<0.1%	2.3E-06	4.8E-06	6.7E-05			
Phenanthrene	1.60E+01	9.92E+05	V	NA	NA	NA	NA	—	NA	NA	NA			
Pyrene	2.41E+00	1.00E+06	P	NA	NA	NA	NA	—	2.1E-06	4.3E-06	NA			
Polychlorinated Biphenyls (PCBs)														
PCB-1254	7.40E-01	m	1.00E+06	P	3.8E-08	7.9E-08	7.7E-10	1.2E-07	4.4%	3.8E-03	7.9E-03			
Inorganic Compounds														
Antimony	2.44E+00	1.00E+06	P	NA	NA	NA	NA	—	1.6E-03	—	NA			
Arsenic	5.55E+00	1.00E+06	P	1.4E-06	5.6E-07	3.3E-08	1.9E-06	72.1%	4.8E-03	2.0E-03	6.8E-03			
Barium	1.86E+02	1.00E+06	P	NA	NA	NA	NA	—	2.4E-04	—	6.8E-04			
Beryllium	9.90E-01	1.00E+06	P	NA	NA	4.3E-09	4.3E-09	0.2%	5.1E-05	—	2.6E-03			
Cadmium	4.71E-01	1.00E+06	P	NA	NA	3.6E-09	3.6E-09	0.1%	1.2E-04	6.7E-05	4.3E-04			
Chromium	4.70E+01	1.00E+06	P	NA	NA	NA	NA	—	8.1E-06	—	NA			
Chromium, Hexavalent	7.40E-01	m	1.00E+06	P	NA	NA	2.0E-07	2.0E-07	7.5%	9.6E-06	—			
Cobalt	1.43E+01	1.00E+06	P	NA	NA	2.4E-07	2.4E-07	8.7%	1.2E-02	—	4.4E-02			
Copper	7.59E+01	1.00E+06	P	NA	NA	NA	NA	—	4.9E-04	—	NA			
Lead	1.60E+02	1.00E+06	P	NA	NA	3.5E-09	3.5E-09	0.1%	NA	NA	NA			
Mercury	1.08E+01	1.00E+06	P	NA	NA	NA	NA	—	9.3E-03	—	6.6E-03			
Molybdenum	1.73E+00	1.00E+06	P	NA	NA	NA	NA	—	9.0E-05	—	NA			
Nickel	2.37E+01	1.00E+06	P	NA	NA	1.1E-08	1.1E-08	0.4%	3.1E-04	—	8.7E-03			
Selenium	2.14E+00	m	1.00E+06	P	NA	NA	NA	NA	—	1.1E-04	—			
Thallium	3.32E+00	1.00E+06	P	NA	NA	NA	NA	—	1.1E-03	—	NA			
Vanadium	5.42E+01	1.00E+06	P	NA	NA	NA	NA	—	2.0E-03	—	NA			
Zinc	7.54E+02	1.00E+06	P	NA	NA	NA	NA	—	6.5E-04	—	NA			

Revised Table F-35
Risk and Hazard Index Calculations for Utility/Trench Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Utility/Trench Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index			
			Oral	Dermal	Inhalation			Oral	Dermal			
			ELCRo	ELCRd	ELCRI	ELCR		HQo	HQd	HQi	HI	
Total Risk or Hazard			Total ELCR			3E-06	100%	Total HI			0.1 100%	
Total Risk or Hazard from Arsenic						2E-06					0.01	
Total Risk or Hazard without Arsenic						8E-07					0.1	

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7 \times \text{CSFo}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 20 \times 7 \times \text{CSFa}) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRI} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 330 \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.8 \times \text{ABSd} \times 20 \times 7) / (1,000,000 \times 70 \times 2,555 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 20 \times 7) / ([\text{VF or PEF}] \times 2,555 \times \text{RfC})$$

Revised Table F-36
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI	
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index	Total HI		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi		
Volatile Organic Compounds (VOCs)												
1,2,4-Trimethylbenzene	7.33E+00	2.90E+04	V	NA	NA	NA	–	NA	NA	8.2E-03	8.2E-03 2.4%	
1,2-Dichlorobenzene	7.40E-03	m	1.43E+04	V	NA	NA	–	8.0E-08	–	5.9E-07	6.7E-07 <0.1%	
1,2-Dichloropropane	2.00E+00	m	3.52E+03	V	2.5E-08	–	4.6E-07	4.9E-07 1.7%	NA	NA	3.2E-02 9.6%	
1,3,5-Trimethylbenzene	1.05E+00		1.15E+04	V	NA	NA	–	2.1E-05	–	3.5E-03	3.5E-03 1.0%	
1,4-Dichlorobenzene	5.20E-03	m	1.28E+04	V	9.8E-12	–	3.7E-10	3.8E-10 <0.1%	NA	NA	1.2E-07 <0.1%	
2-Hexanone	1.63E-03	m	1.53E+04	V	NA	NA	–	NA	NA	NA	NA –	
Benzene	1.14E+00		2.68E+03	V	4.0E-08	–	1.0E-06	1.0E-06 3.6%	2.8E-04	–	1.6E-03 1.9E-03 0.6%	
Carbon Disulfide	1.90E-02	m	1.17E+03	V	NA	NA	NA	–	1.9E-07	–	4.6E-06 4.8E-06 <0.1%	
Chloroform	1.14E-01		2.61E+03	V	1.2E-09	–	1.9E-08	2.0E-08 <0.1%	1.1E-05	–	3.3E-05 4.4E-05 <0.1%	
Ethylbenzene	1.16E+00		5.29E+03	V	4.5E-09	–	4.5E-08	4.9E-08 0.2%	1.1E-05	–	2.5E-05 3.6E-05 <0.1%	
Iodomethane	2.25E-03	m	1.32E+09	P	NA	NA	NA	–	NA	NA	NA –	
Isopropylbenzene	3.94E-01		1.65E+03	V	NA	NA	NA	–	3.9E-06	–	1.4E-04 1.4E-04 <0.1%	
Methyl-t-Butyl Ether (MTBE)	2.85E+00	m	4.07E+03	V	1.8E-09	–	1.5E-08	1.7E-08 <0.1%	NA	NA	2.0E-05 2.0E-05 <0.1%	
n-Butylbenzene	3.65E-01		7.83E+03	V	NA	NA	NA	–	NA	NA	NA –	
n-Propylbenzene	4.95E-01		6.62E+03	V	NA	NA	NA	–	NA	NA	NA –	
o-Xylene	7.33E-01		5.16E+03	V	NA	NA	NA	–	3.6E-07	–	4.6E-05 4.7E-05 <0.1%	
p/m-Xylene	8.96E+00		3.79E+03	V	NA	NA	NA	–	4.4E-05	–	5.4E-03 5.4E-03 1.6%	
p-Isopropyltoluene	3.74E-01		8.17E+03	V	NA	NA	NA	–	NA	NA	NA –	
sec-Butylbenzene	2.33E-01		7.06E+03	V	NA	NA	NA	–	NA	NA	NA –	
Styrene	2.50E-01	m	1.32E+04	V	NA	NA	NA	–	1.2E-06	–	4.8E-06 6.0E-06 <0.1%	
Tert-Butyl Alcohol (TBA)	2.09E-02		1.95E+04	V	NA	NA	NA	–	NA	NA	NA –	
tert-Butylbenzene	2.80E-01	m	7.06E+03	V	NA	NA	NA	–	NA	NA	NA –	
Tetrachloroethylene	4.00E-02	m	2.50E+03	V	7.5E-09	–	7.7E-09	1.5E-08 <0.1%	3.9E-06	–	1.0E-04 1.1E-04 <0.1%	
Toluene	4.58E-01		3.90E+03	V	NA	NA	NA	–	5.6E-06	–	8.9E-05 9.5E-05 <0.1%	
Vinyl Acetate	9.80E-03	m	4.69E+03	V	NA	NA	NA	–	9.6E-09	–	2.4E-06 2.4E-06 <0.1%	
Xylenes, total	9.19E+00		4.39E+03	V	NA	NA	NA	–	4.5E-05	–	6.8E-04 7.3E-04 0.2%	
Semivolatile Organic Compounds (SVOCs)												
1-Methylnaphthalene	2.19E+01		1.63E+05	V	2.2E-07	–	NA	2.2E-07 0.8%	NA	NA	NA –	
2-Methylnaphthalene	2.93E+01		1.13E+05	V	NA	NA	NA	–	7.2E-03	–	NA 7.2E-03 2.1%	
Acenaphthene	3.97E+00		2.12E+05	V	NA	NA	NA	–	6.5E-05	1.1E-04	NA 1.8E-04 <0.1%	
Acenaphthylene	6.62E-02		1.63E+05	V	NA	NA	NA	–	NA	NA	NA –	
Anthracene	1.39E-01		7.70E+05	V	NA	NA	NA	–	4.5E-07	7.8E-07	NA 1.2E-06 <0.1%	
Benzo(a)anthracene	1.26E-01		1.32E+09	P	5.3E-08	9.0E-08	8.5E-13	1.4E-07 0.5%	NA	NA	NA –	

Revised Table F-36
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent Total ELCR	NON-CANCER HAZARD INDEX			Percent Total HI			
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index					
			Oral	Dermal	Inhalation				Oral					
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	HI			
Benzo(a)pyrene	7.23E-02	1.32E+09 P	3.0E-07	5.2E-07	4.9E-12	8.2E-07	2.8%	NA	NA	NA	NA –			
Benzo(b)fluoranthene	4.25E-02	1.32E+09 P	1.8E-08	3.1E-08	2.9E-13	4.8E-08	0.2%	NA	NA	NA	NA –			
Benzo(ghi)perylene	1.10E-01	1.32E+09 P	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Benzo(k)fluoranthene	3.70E-02	1.32E+09 P	1.6E-08	2.7E-08	2.5E-13	4.2E-08	0.1%	NA	NA	NA	NA –			
Chrysene	4.69E-01	1.32E+09 P	2.0E-08	3.4E-08	3.2E-13	5.3E-08	0.2%	NA	NA	NA	NA –			
Dibenzo(a,h)anthracene	5.91E-02	1.32E+09 P	8.5E-08	1.4E-07	4.4E-12	2.3E-07	0.8%	NA	NA	NA	NA –			
Fluoranthene	1.56E-01	1.32E+09 P	NA	NA	NA	NA	–	3.8E-06	6.5E-06	NA	1.0E-05 <0.1%			
Fluorene	4.70E+00	5.02E+05 V	NA	NA	NA	NA	–	1.1E-04	2.0E-04	NA	3.1E-04 <0.1%			
Indeno(1,2,3-cd)pyrene	3.55E-02	1.32E+09 P	1.5E-08	2.5E-08	2.4E-13	4.0E-08	0.1%	NA	NA	NA	NA –			
Naphthalene	1.80E+00	5.49E+04 V	NA	NA	9.1E-08	9.1E-08	0.3%	8.8E-05	1.5E-04	8.3E-04	1.1E-03 0.3%			
Phenanthrene	1.60E+01	9.92E+05 V	NA	NA	NA	NA	–	NA	NA	NA	NA –			
Pyrene	2.41E+00	1.32E+09 P	NA	NA	NA	NA	–	7.9E-05	1.3E-04	NA	2.1E-04 <0.1%			
Polychlorinated Biphenyls (PCBs)														
PCB-1254	7.40E-01 m	1.32E+09 P	5.2E-07	8.8E-07	2.6E-11	1.4E-06	4.8%	3.6E-02	6.2E-02	NA	9.8E-02 29.0%			
Inorganic Compounds														
Antimony	2.44E+00	1.32E+09 P	NA	NA	NA	NA	–	6.0E-03	–	NA	6.0E-03 1.8%			
Arsenic	5.55E+00	1.32E+09 P	1.8E-05	6.3E-06	1.1E-09	2.5E-05	83.8%	1.8E-02	6.2E-03	6.4E-05	2.4E-02 7.2%			
Barium	1.86E+02	1.32E+09 P	NA	NA	NA	NA	–	9.1E-04	–	6.4E-05	9.7E-04 0.3%			
Beryllium	9.90E-01	1.32E+09 P	NA	NA	1.5E-10	1.5E-10	<0.1%	4.8E-04	–	2.4E-05	5.1E-04 0.2%			
Cadmium	4.71E-01	1.32E+09 P	NA	NA	1.2E-10	1.2E-10	<0.1%	4.6E-04	2.1E-04	4.1E-06	6.8E-04 0.2%			
Chromium	4.70E+01	1.32E+09 P	NA	NA	NA	NA	–	3.1E-05	–	NA	3.1E-05 <0.1%			
Chromium, Hexavalent	7.40E-01 m	1.32E+09 P	NA	NA	6.9E-09	6.9E-09	<0.1%	2.4E-04	–	6.4E-07	2.4E-04 <0.1%			
Cobalt	1.43E+01	1.32E+09 P	NA	NA	8.0E-09	8.0E-09	<0.1%	4.7E-02	–	4.1E-04	4.7E-02 13.9%			
Copper	7.59E+01	1.32E+09 P	NA	NA	NA	NA	–	1.9E-03	–	NA	1.9E-03 0.5%			
Lead	1.60E+02	1.32E+09 P	NA	NA	1.2E-10	1.2E-10	<0.1%	NA	NA	NA	NA –			
Mercury	1.08E+01	1.32E+09 P	NA	NA	NA	NA	–	3.5E-02	–	6.2E-05	3.5E-02 10.4%			
Molybdenum	1.73E+00	1.32E+09 P	NA	NA	NA	NA	–	3.4E-04	–	NA	3.4E-04 0.1%			
Nickel	2.37E+01	1.32E+09 P	NA	NA	3.8E-10	3.8E-10	<0.1%	1.2E-03	–	8.2E-05	1.2E-03 0.4%			
Selenium	2.14E+00 m	1.32E+09 P	NA	NA	NA	NA	–	4.2E-04	–	1.9E-08	4.2E-04 0.1%			
Thallium	3.32E+00	1.32E+09 P	NA	NA	NA	NA	–	5.0E-02	–	NA	5.0E-02 14.8%			
Vanadium	5.42E+01	1.32E+09 P	NA	NA	NA	NA	–	7.6E-03	–	NA	7.6E-03 2.2%			
Zinc	7.54E+02	1.32E+09 P	NA	NA	NA	NA	–	2.5E-03	–	NA	2.5E-03 0.7%			

Revised Table F-36
Risk and Hazard Index Calculations for Hypothetical Future Onsite Commercial/Industrial Worker Receptor
from Exposure to Subsurface Soil (0- to 10-ft Depth Interval)
Area 4

Baseline Human Health Risk Assessment
Former CENCO Refinery
Santa Fe Springs, California

Scenario Timeframe: Future
 Receptor Population: Site Worker
 Receptor Age: Adult

Constituent	EPCs (mg/kg)	VF or PEF [a] (m³/kg)	CANCER RISK			Calculated Risk	Percent ELCR	NON-CANCER HAZARD INDEX			Percent Total HI
			Route-Specific Risk					Route-Specific Hazard Quotient	Calculated Hazard Index		
			ELCRo	ELCRd	ELCRi	ELCR		HQo	HQd	HQi	
Total Risk or Hazard			Total ELCR			3E-05	100%	Total HI			0.3 100%
Total Risk or Hazard from Arsenic						2E-05					0.02
Total Risk or Hazard without Arsenic						5E-06					0.3

Notes:

[a] Minimum of the volatilization factor (identified with [V]) derived in Table 6-19 and the particulate emission factor (identified with [P]).

* EPCs exceeds the soil saturation limit (Csat) (Table 6-19); therefore, volatilization is based on the Csat concentration instead of EPCs.

– = not applicable

ELCR = excess lifetime cancer risk

EPCs = exposure point concentration in soil

HI = hazard index (sum of the HQs)

HQ = hazard quotient

m = EPC based on maximum

m³/kg = cubic meters per kilogram

mg/kg = milligrams per kilogram

NA = not available

PEF = particulate emission factor

VF = volatilization factor

Equations:

$$\text{ELCRo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25 \times \text{CSF}_0) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25 \times \text{CSF}_a) / (1,000,000 \times 70 \times 25,550)$$

$$\text{ELCRi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25 \times \text{URF}) / ([\text{VF or PEF}] \times 25,550)$$

$$\text{HQo} = (\text{EPCs} \times 1 \times 100 \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDo})$$

$$\text{HQd} = (\text{EPCs} \times 5,700 \times 0.2 \times \text{ABSD} \times 250 \times 25) / (1,000,000 \times 70 \times 9,125 \times \text{RfDa})$$

$$\text{HQi} = (\text{EPCs} \times 8 \times 0.042 \times 250 \times 25) / ([\text{VF or PEF}] \times 9,125 \times \text{RfC})$$